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FOUR RESEARCH STUDIES ON THE BLIND ARE PRESENTED--"CANE TRAVEL--TECHNIQUES AND DIFFICULTIES" BY D. LIDDLE, "THE MUSICAL ABILITY OF BLIND CHILDREN" BY DEREK J. PITTMAN, "THE EVALUATION OF VERBAL PERFORMANCE IN MULTIPLY-HANDICAPPED BLIND CHILDREN" BY W. SCOTT CURTIS, AND "THE EVALUATION AND SIMULATION OF MOBILITY AIDS FOR THE BLIND" BY ROBERT W. MANN. SEVERAL OF THE ARTICLES PROVIDE TABLES, OUTLINES, AND REFERENCE LISTS. THIS DOCUMENT IS A PUBLICATION OF THE AMERICAN FOUNDATION FOR THE BLIND, 15 WEST 16TH STREET, NEW YORK, NEW YORK 10011. (JD)

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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for the Blind

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CANE TRAVEL: TECHNIQUES AND DIFFICULTIES

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INTRODUCTION

The observation and study of the mobility of the blind - now sometimes called "peripatology" - has a fairly continuous history extending over at least the past two hundred years. In general the early history comprised observations of, or anecdotes from individual blind people, followed by a long series of studies of what was variously termed the "obstacle sense," "object sense," or "facial vision." By this was meant the ability of many blind people to detect obstacles at a distance and avoid them. The results of these studies showed that hearing is the necessary and sufficient basis of such detection, and more recent investigators have looked at (1) the development of such auditory abilities with age, (2) the extent of these abilities in the blind, and (3) the extent of these abilities in bats and other animals which do not rely primarily on vision to find their way about. Linked with this last, and with modern developments in technology, have come attempts to supplement the existing abilities of the blind traveler with guidance devices using a beam of light, or sound energy (audible or ultrasonic in frequency) which is reflected by objects in its path and received by another part of the equipment. Alternatively, a very few studies have taken a good look at existing modes of travel such as use of cane or guide dog, in an attempt to compare their efficiencies and their disadvantages.

And yet, in all this wealth of research, one looks in vain for opinions and comments sought from the people most involved. There is at least one exception, a study by the Haskins Laboratories, New York, in 1944. Blind travelers were asked to say what obstacles and situations they found most difficult to negotiate. The informants were primarily concerned with the harmfulness of an encounter, rather than with the frequency with which an object is met. But this one exception only makes the absence of others more conspicuous. Surely, if one is attempting to develop guidance devices to help blind travelers, one of the very first steps should be to ask them just what the problems are, so that one can see what assistance is most necessary. Even if all the answers turn out to be just what one would expect, one is still on firmer ground for having asked.

In an attempt to gather together more first-hand material, I compiled a questionnaire on the problems of mobility, and the editor of *The New Beacon* (published monthly by the Royal National Institute for the Blind), kindly included this in the issue of June, 1964. *The New Beacon* appears both in print and in braille, is read both by blind readers and by those working on behalf of the blind, e.g., home teachers, and has a circulation of approximately 1000 braille, and 2300 printed copies. The response far exceeded anything I dared to hope for, both in quantity and in quality. The replies were clear, well-thought-out, and usually included much valuable information over and above that requested. I should like to take this opportunity of setting on record my grateful thanks to all those who went to so much effort and so willingly entered into the spirit of the enquiry.

The Questionnaire

The questions, preceded by the text inviting replies, were as follows.*

A good deal has been written, over the years, about mobility and blindness, a fair proportion of it in the pages of *The New Beacon*. The study of particular aspects of the subject, for instance "facial vision," has often been quite fully documented, all the way from anecdotes marveling at the uncanny powers possessed by some blind people to reports of carefully conducted scientific experiments. One also finds a number of well-thought-out descriptions by individual blind men and women of the problems they encounter in traveling and the methods by which these problems are overcome. It does seem to me, however, that most of the available literature on this subject has been written by people who are not themselves blind, but who sit down, as it were, to think the thing out logically: "Take away sight, what does that leave? Right, let's start from there." I have not come across any discussion of mobility which approached the subject from the other end, i.e., by asking a large number of blind people what the difficulties of travel are, and how they cope with them.

Obviously the best way of doing this would be to go out and interview a suitably large number of people, but the difficulties involved in doing this are equally obvious. I have therefore tried to do the next best thing, to ask at least some of the relevant questions below, in the hope that readers who do not have any useful "travel vision" may feel inclined to help me to get together a body of data based not on theory but on actual personal experience. Many of the questions may strike you as not very

* The text inviting replies and the questions in this section have been published in The New Beacon, Vol. XLVIII, No. 566 (June 1964), pp. 491-493, and in Appendix IV of the Proceedings of the Rotterdam Mobility Research Conference. New York: American Foundation for the Blind, 1965, pp. 289-292 (in press).

profound and perhaps rather unnecessary. As a blind person myself, I tend to feel that I could probably predict most of the answers. Perhaps I should be right in assuming that what I find awkward others also find awkward, but how much more useful to have some actual evidence on such points, rather than so many assumptions. Only too often one comes across a tendency to lump us all together as "the blind," who all know each other, are all highly musical, etc. It may well be, however, that as we are dealing here with questions of perception, rather than of personality, we can expect to find problems and solutions common to most people.

I do hope that when you have read over these questions, and have given some of them a little thought, perhaps when out walking, you will take up Stainsby or Perkins, braille frame or typewriter, and have a go at them, after first putting down your name, age, and age when you became blind.

A number of the questions will not apply to those who travel with a guide dog, or to those who use neither dog nor stick, but I should be very grateful for answers to the questions that do seem applicable.

1. When walking outdoors by yourself, do you prefer to wear shoes with nails or steel tips, so that they make a certain amount of noise, or shoes that make very little noise, e.g., rubber soles and heels?

2. Do you carry a stick and, if so, do you just *carry* it or do you use it? If you use it, do you normally just tap it on the pavement, or do you use it to touch the wall, fence, etc.?

3. Which do you prefer to be walking alongside: fence, wall, railings, or hedge? In what order of preference would you put the other three?

4. Do you usually keep towards the inside of the pavement, or more towards the outside, following the curb?

5. If you are ever out alone, without a stick, how do you get on, and how does it feel?

6. What weather conditions (not necessarily those which do, or even could, occur together) do you find the most trying from the point of view of getting around?

7. Given reasonable weather conditions, what sort of places do you find awkward to negotiate? Perhaps you would care to list several, in order of decreasing difficulty, and to add a few thoughts on the origins of the difficulties?

8. Remembering that this is all confidential, and that no names will be mentioned, would you say that you get all the help you want in getting about, or that you get rather more help than you want, or that sufficient help is forthcoming but of the wrong kind? Any other comments?

9. Is it your impression that you "naturally" walk in a straight line, or that keeping on course demands a conscious effort to correct a tendency to veer off?

10. Would you be prepared to say that, when it comes to getting about, hearing and the use of a stick do essentially the same job, the stick simply supplying information for the hearing to use? Or would you say that the two have different parts to play, that the stick takes care of some things and hearing of other things? If so, what functions would you assign to each of them, forgetting for the moment that the color of the stick has any significance.

11. Do you think that you use your hearing more or less when getting about indoors, as compared with walking outdoors?

12. What is your own private theory about this "sixth sense" which is said to warn blind people of nearby obstacles?

13. Among the common obstacles to be met with outdoors, which do you find to be the greatest menace and why?

14. Some blind people can detect obstacles at quite surprising distances, others are not so lucky. What sort of obstacles do you yourself find detectable, and at what distances, roughly?

15. Have you ever been quite certain that there was something in your way, only to find that there wasn't? How did you explain this illusion?

16. Do you usually/ever find it helpful to make some additional noise, such as clicks with the tongue or fingers, when you think that there may be an obstacle but cannot be certain? If so, what sort of noise do you find the most useful?

17. Blind people are often supposed to have keener hearing and a more discriminating sense of touch than the average sighted person. Does your own experience lead you to feel that either or both of these suppositions is true in your own case?

18. Do you ever/often go for a walk by yourself, just for the enjoyment, or is all your walking a means of getting somewhere?

19. How much of an effort, or how tiring, do you find getting about alone on foot?

20. As you will know, there have been a number of attempts to develop satisfactory "guidance devices," some of which are still making progress. Some of these devices use sound to indicate the presence of potential obstacles, others make use of the sense of touch. Such devices have usually included somethi resembling a torch, to be carried in the hand, a power unit, either on a sling or in the pocket, and a third part fitting in o on the ear, on the forehead, or on the chest. Assuming that bo types were available here and now (which is, alas! only an assumption), and both at the same very reasonable price, would yo wish to have such a device yourself? If so, which, that involv hearing or that using touch? (Let us also assume that they are equally efficient.) To what extent would you insist that such device should be completely inconspicuous?

The questions were arrived at partly by experience and par by a vaguely logical process. For a blind traveler walking alo cane or stick in hand, two categories of sensory information ar of the greatest importance. A great deal of kinesthetic information can be actively sought out by the hand and arm, using a stick. Information of the same type also comes from the feet, from those bodily systems concerned with awareness of position movement. Secondly, there is auditory information; the percept of sounds or of sound reflections, "sound shadows" or distortio The sounds of the environment may be supplemented by those produced by the traveler himself. At least ten of the questions c cern these different types of information. Thus one would like know what sensory information is the most helpful, and to what tent the various sorts of information overlap or have specific roles to play. What happens when the traveler does not have a stick, or when weather or place minimize the available sound cu Precisely how do the people in the sample use their sticks, and how many make any attempt - by wearing noisy shoes or by making other noises - to increase the auditory cues?

Several questions are aimed at pinpointing the difficultie experienced by blind travelers, difficulties created by weathe place, obstacles, illusion, or efforts to maintain a straight course, and to discover the felt origins of these difficulties. How much strain does this kind of travel put upon the individua sufficient to rule out walking for pleasure? How much assista does he receive from the general public? Could this be improve in any way? What kind of "guidance device" would be most welc

Information about the sensory data a blind traveler makes of, and about the nature and the magnitude of the difficulties experiences, could obviously be of great value in planning suc aids to mobility and in mobility training generally.

Finally, a few of the questions were prompted by some of "superstitions" about the blind, which still linger on. How m blind people do actually tap their way along, following the cu

How many would claim that they have a "sixth sense," or an acuity of hearing or sensitivity of touch far beyond those of the average sighted person?

Important: In reading what follows, one point must be borne in mind; it may seem rather obvious, but its importance can hardly be overemphasized. Answers to such a questionnaire as this must always be regarded as constituting expressed opinions, rather than established facts. This is not difficult to see in, for instance, Question 20, where one assumption is heaped upon another and topped with a choice between two hypothetical devices. Similarly, Questions 5, 9, 11, and 14 can scarcely be answered with the precision that might be expected of a laboratory study! What people *think* they do may or may not correspond with what they actually do, however honest the reply. Nevertheless it is hoped that the survey, with all its faults, may yet serve a useful purpose.

THE SURVEY

In the following pages two categories are frequently distinguished and compared: the "early blind" and the "late blind." Such a distinction was found useful by Worchel (8) in his study of "Space Perception and Orientation in the Blind," and by Drever (2) in comparing the abilities of blind and sighted subjects on figure recognition, orientation, and classification. Duncan (3) finds that "the present degree of vision is of much less importance... than the amount and duration of visual experience...." where ability to learn a finger maze is concerned. A great many people have, of course, stressed the importance of early learning as a basis for later learning, foremost among the most recent being Hebb (5). By "early blind" in the present paper is meant those blind from birth, or who lose their sight in childhood or early adolescence; the remainder, those becoming blind as adults (age 20 or upwards) are counted as "late blind."

This cut-off point is rather arbitrary and many may disagree with its placing. There are, however, at least two pointers to a possible dividing line somewhere in adolescence. First, there is the finding by Gomulicki (4) that, when sighted and congenitally blind children of various ages are compared on tactile and auditory tasks, it is not until about the mid-teens, in many cases, that the blind children achieve the same level of performance as the sighted. From this it seems that one could expect anyone becoming blind at such a time to start off with tactile and auditory capabilities roughly equal to those of his congenitally blind contemporary. Second, a statement by Ivo Kohler (6) in his excellent paper on "Orientation by Aural Cues" suggests that after the age of 20 or thereabouts one's sensitivity to sounds of high frequency begins to deteriorate, followed by sensitivity to the middle frequency range. As it appears also that higher frequencies give the best "echo response," it seems likely that those becoming blind after 20 may have increased difficulty in learning to use auditory cues in their traveling about, where these involve reflected sound.

The Sample

From just over 100 replies to the questionnaire, the most detailed and informative 100 were selected and used for this analysis. This was felt to be a particularly convenient number to work with, and also has the merit that the results can, if desired, be expressed as percentages of the population sampled.

The 100 subjects are drawn from upwards of 50 cities, towns, and villages of England, several from Scotland and Wales, and 6 from overseas. It would be interesting to know the size of the population the sample represents, but this is unfortunately not possible. One can only suggest - with great hesitation - that from statistics recently published it *could* be that this sample represents 1 in every 140 of those who travel about in Great Britain, between the ages of 16 and 70, without any appreciable sight, and with no escort or guide dog.

Replies had been invited from readers "who do not have any useful 'travel vision'." It may be, as some have suggested, that this factor should have been more carefully controlled. However, it would have been difficult - impossible - to have specified degree of vision more narrowly in a questionnaire of this kind, and it was felt that the individual could be relied upon to know, and to say, whether or not any residual vision came within the definition "useful 'travel vision'." As it turned out, most people volunteered details on this point.

Nevertheless, the 14 with perception of light or "little vision" have been handled with extra care, although their answers give no reason for serious misgivings about their inclusion. Indeed, it is noticeable that just a little vision can actually be a handicap on many occasions, not an advantage.

Age at onset of blindness of the 100 subjects is listed in Table 3. One-fourth of the sample, 27, were blind at birth, almost one-half before age 5, and three-fourths by age 20.

It should perhaps be mentioned here that 11 people suffer from some degree of hearing impairment, and that this has been taken into account wherever it might be a relevant factor.

It is clearly desirable to compare the distribution of this sample, both as regards present age and age at blindness, with that of the population being sampled. The only available figures with which to make such a comparison are those published by the Ministry of Health with reference to registered blind people in England and Wales on 31 December, 1963. Graphic comparisons are shown in Appendix A.

The 100 comprised 67 men and 33 women.

TABLE 1

DISTRIBUTION OF SAMPLE BY SEX AND AGE

Age	Men	Women
10 to 20	2	1
20 to 30	3	7
30 to 40	15	5
40 to 50	12	8
50 to 60	17	2
60 to 70	11	7
70 and over	3	2
Unknown	4	1

Average age: Men, 47.94, range 12-75.
Average age: Women, 44.41, range 19-74.

TABLE 2

DISTRIBUTION OF SAMPLE BY AMOUNT OF VISION

Totally blind	49
"Blind"	34
Perception of light	9
"Little vision"	5
Unspecified	3

TABLE 3

DISTRIBUTION OF SAMPLE BY AGE AT ONSET OF BLINDNESS

Birth to 5	45
5 to 10	14
10 to 15	6
15 to 20	6
20 to 25	4
25 to 30	3
30 to 35	2
35 to 40	6
40 to 45	2
45 to 50	3
50 to 55	3
55 to 60	0
60 to 65	2
Unknown	4

The sample is obviously not truly representative of the blind population. There is no representation at all of the 1 percent of that population aged 10 or less, nor of the 32 percent aged 80 or more. Women of 50 and over, and men of 70 and over, are not adequately represented. A true sample should include an equal proportion of men and women aged 10 to 70; the present one is heavily biased in favor of men, particularly in the range 30 to 60. However, as it seems unlikely that large numbers of those aged 80 and over engage in much "independent" travel, it may be that the sample is reasonably representative of blind travelers, except for the bias.

Comparison of the sample with the larger population in respect of age at onset of blindness reveals that the former is very heavily weighted in favor of those blind at birth or before age 10, and, to a lesser extent, those becoming blind between ages 10 and 40. Those becoming blind after 40 are not sufficiently represented, while the 44 percent losing their sight after age 65 are completely absent.

Although the sample appears to be so atypical of the larger population, the reader may feel that the frequent analyses by present age and by age at blindness go some way towards meeting objections on this count. It may well be that the estimated 21 percent of blind people in the United Kingdom who read braille are not themselves a fair sample of the blind population generally, and that readers of *The New Beacon* are not typical of this 21 percent, or that those who reply to questionnaires are not truly representative of readers of *The New Beacon*, but these are factors which clearly could not be controlled.

The Replies

Question No. 1

When walking outdoors by yourself, do you prefer to wear shoes with nails or steel tips, so that they make a certain amount of noise, or shoes that make very little noise, e.g., rubber soles and heels?

Sixty-six people prefer shoes that make a noise: of these, 37 say tips or "noisy"; 29 specify "some noise," a certain amount but not too much or too obvious; 12 don't mind what sort of shoes they wear; and 22 prefer quiet shoes.

TABLE 4

PREFERRED FOOTWEAR: AVERAGE AGE (IN YEARS) AT ONSET OF BLINDNESS VS. PRESENT AVERAGE AGE

Preferred Footwear	Blindness	Present
"Noisiest"	3.25	46.22
"Noisier"	12.19	45.78
Don't mind	15.50	49.73
Quiet	39.92	55.68
And	0.86	36.00

Those preferring quiet shoes so obviously do not comprise a homogeneous group that they have been shown as two distinct groups: "quiet" and "and"; the second appearance represents 7 subjects, all well below average age, and all becoming blind very early. It looks as though there may be a link between preferred footwear and age of loss of sight (although clearly not a straightforward one), and the results have been set out in more detail for greater clarity in Table 5.

TABLE 5

PREFERRED FOOTWARE BY AGE AT ONSET OF BLINDNESS

Age at onset of blindness	Preferred footware "Noisiest"	"Noisier"	Don't mind	Quiet
Birth to 10	30	15	7	7
10 to 20	1	8	2	1
20 to 30	2	2	1	2
30 to 40	0	4	0	4
40 to 50	1*	0	0	4
50 to 60	0	0	1	2
60 to 65	0	0	1	1
Unknown	3	0	0	1
	37	29	12	22

* This subject is purely theoretical in that she thinks she would prefer such shoes if she went out; at present she does not go out and wears quiet shoes.

So, of those blind before age 10 three-quarters prefer noise; with the 10 to 20's the proportion is the same but the emphasis has shifted to "some" noise, but not too much; the 20 to 40's are a little spread, while three-quarters of the after-40's prefer quiet shoes.

Apparently there is a connection between the age at which blindness occurs and the preference for noisy shoes. An obvious conclusion would be that older people tend towards rubber soles and heels because steel tips or nails are undeniably slippery when they become a little worn. This may be a contributory factor, but the usual reason given is that "I prefer quiet shoes...so that I can hear people approaching." One person feels that rubbers are more restful, another that he is better able to "appreciate gradations or changes in surface texture" (of the pavement). The replies given a distinct impression - which will be referred to often in connection with later questions - that those becoming blind in later life probably rely less on sounds reflected from nearby objects than do the early blind, and are concerned rather with the sounds that surrounding objects or people produce themselves.

But what then of the 7 early blind who do not mind what sort of shoes they wear and the 7 who prefer quiet shoes? Is one to conclude that they make little or no use of echoes from the objects around them? Five out of the 14 find additional noise helpful when faced by uncertainty as to the presence of an obstacle. This figure compares well enough with the figures from the whole sample. All 14 report being able to detect obstacles by echo, and they include quite a lot of the most remarkable detection abilities of the sample as a whole. There can be no doubt at all that these people make use of echoes, but they find that the sound of their own footsteps "confuses the picture rather than helps." An obvious hypothesis is that these subjects have particularly sensitive hearing. It may also be that they tend to travel in areas where the background noise is not too high. Experimental evidence suggests that most, if not all, blind people find object detection possible even in a supposedly silent environment, but that performance is greatly enhanced by even a very little sound being present. Similarly, although most people could probably manage with rubber soles and heels, the majority find an amount of extra noise helpful. Some apparently find this unnecessary, and the older subjects probably find it unhelpful.

Question No. 2

Do you carry a stick and, if so, do you just *carry* it, or do you use it? If you use it, do you normally just tap it on the pavement, or do you use it to touch the wall, fence, etc.?

Ninety-eight of the 100 do have a stick, one of those with a little vision does not have one, and one totally blind man "tried, but gave up" using one. Sixteen mainly carry a stick, as opposed to using it. The remaining subjects with a "little vision" account for 4 of these; of the other 12, 11 lost their sight very early (average 1.5 years), while 9 of the 12 are noticeably younger now than the average age (27.1 as against 46.16). Over and above these 16, several people say that they did not use or carry a stick when younger and/or living in quieter surroundings, and 1 who used to "carry" finds himself now using. Five of the "carriers" use their stick in an unfamiliar place and 3 use it when there is a lot of noise or no wall. In common with most others, they use a stick to locate steps or curbs. It seems that even folded away in one's brief case, the stick gives greater confidence to the traveler! Just how people feel without their stick and how well or how badly they manage, emerges from Question No.5.

The principal use of the stick is to keep one on course by touching the wall from time to time; one aims to keep a certain distance from the wall, far enough out to miss anything propped against, jutting out from, or standing by the wall, but near enough to be able to follow it by stick or hearing and to avoid the multitude of hazards towards the edge of the pavement. Thus, 72 people mention touching the wall: 4 touch lightly or gently, 12 touch occasionally and 3 sometimes, "from time to time," "as necessary," "fairly often," "every 3 to 4 steps," "perhaps every 10 steps, or every step with a very irregular boundary."

Three, who walk on the side of the pavement nearest the road (see Question No. 4) use their stick to follow the curb. Ten people mention that they sometimes "trail" their stick: 5 along grass verges; 4 along walls; 1 along the curb. Of those who "trail" along walls, 1 only does so when in extremely noisy surroundings, and 1 has a rubber-tipped stick, so that the operation is comparatively noiseless and inconspicuous. I heard somewhere recently of a blind man with a stick which had at its foot a small rubber wheel, so that it could be propelled quietly along the pavement ahead. Such a stick would seem ideal for "trailers."

The stick is also useful for finding curbs and steps (mentioned by at least 25) and for guarding against obstacles - 12 (see also Question 10).

Eighteen explicitly deny tapping, and most of the rest deny it implicitly. Ten people do tap, 3 more do so sometimes, and 4 use the Hoover Cane Technique (3 are Americans) which involves tapping. Many blind people have a strong feeling against tapping, on the grounds that it is "very blind." Similar feelings also come up in connection with making any additional noise (Question 16). This called forth quite a lot of indignation and battalions of exclamation marks. Again, when we come to guidance devices (Question 20), there are comparatively few people who do not mind at all whether the device is conspicuous. It is not a new thought, but it is one which this whole survey points up again. Mobility, for the most of us who cannot see, involves a compromise between an ideal use of our remaining abilities and the appearances we are prepared to present to the general public and, to some extent, to our fellow blind. Thus, logically it might be that a "shield-like" affair, as tall and as wide as the person behind it, and perhaps running along on wheels, would be the best possible solution. But who, just who, would be prepared to use such a thing?

However, with tapping, prejudice probably plays a very small part. I suggest that it is quicker and easier to touch the wall that one is passing than to tap the pavement, that one can walk more quickly, and that the information from a touch on the wall is generally more useful. It all depends, too, on whether a change in "ground level" is or is not more likely than a change in the building line. Most, if not all, people will resort to tapping when expecting a step but, as a general rule, one does not expect steps as long as the wall continues unbroken, so that its sudden ending provides just about as much warning as tapping the pavement ahead.

Do people tap because they use the resulting sounds or are they using the stick as a probe, a third foot with which to test the ground ahead? Only 6 of the 17 tappers ever use additional noises when uncertain about a possible obstacle, 13 can detect obstacles through echoes and a further 1 is uncertain. It looks as though 3 at any rate are using the stick as a probe, not for any sound. For the rest, the functions are probably mixed. A further 22 resort to one or two taps when faced by an open space or uncertainty about an obstacle, mainly for the sake of the noise. On the other hand, there are very few people who manage very well without a stick to use as a probe even though their hearing is unaffected. It seems certain, therefore, that people may tap for both reasons. There is no common feature of age either now or at blindness, nor of preferred footwear, to distinquish tappers from nontappers. It seems to be simply a matter of habit, perhaps of any mobility training that one has had.

Note: It should be made clear that the term "stick" has been used throughout this and other questions simply as the generic term. No attempt has been made to classify people according to the type of stick they use. It is probably true that most of the 100 subjects use a collapsible metal "cane" rather than the solid wooden "stick," the ordinary white walking stick. One might expect the more infirm to prefer the stouter walking stick, but all have been lumped together here as sticks, without distinction as to material, length, crook handle, or anything else. Only one "stick" is not white.

Question No. 3

Which do you prefer to be walking alongside: fence, wall, railings, or hedge? In what order of preference would you put the other three?

TABLE 6

PREFERENCE ORDER FOR GUIDE LINES

	Choice			
Guide Line	First	Second	Third	Fourth
Wall	87	3	1	0
Fence	2	62	20	5
Railings	1	17	48	19
Hedge	1	8	19	61

The greatest measure of agreement concerns the decided advantages of a wall, which is both easier to hear and to follow with the stick. There is least agreement about railings: 18 people find railings even worse than a hedge; 16 rate them above a fence, second only to a wall. This is probably due to the widely varying concept of "fence"; several people stipulate that a fence to rate second must be close-palinged not, for instance, wires or chains slung between posts.

On the face of it there is 73 percent agreement with an order of wall, fence, railings, hedge (46 actually give this order): 5 have no preference; for 1 person, the choice "depends solely on familiarity," while the only important thing for 2 more is the absence of jutting-out bits.

Hedge

Hedges are often unkempt, overhanging the pavement and presenting thorns to scratch the face or twigs to poke the eye; after wet weather they are loaded with rain, to be deposited in the face and down the neck of the unfortunate traveler. One can also get the stick caught up in a hedge.

Railings

As with hedges, railings reflect comparatively little sound for the ears to use; their open character likewise makes them rather unsuitable for following with the stick. With a metal stick, or a substantial wooden one "[illegible]ttling and clanging is difficult to avoid." There is a very real danger of catching the stick between two uprights.

Fence

A fence has the advantages of a wall, or the drawbacks of railings, according to its character.

Wall

This is, of course, the easiest to follow with the stick, largely through its continuity, and the easiest to hear provided that it is of the right height, a point mentioned by 15 people. A wall must be: "high," "not low," "5 feet," "waist" or "thigh-high," "as high as me," "2 feet," "above 3 feet unless it is very quiet." It is interesting that all 15 are early blind.

[illegible]t appears that this order, wall, fence, railings, hedge, is pre[illegible]able whether one is using stick, ears, or both to keep on course. Thirteen of the 16 who mainly carry their stick, as against using it, still prefer this order (the other 3 say "immaterial"), as do the 2 without a stick, 8 out of the 9 who walk in the middle of the pavement (Question 4), 9 of the 10 who walk either on the inside or the outside according to convience, 4 out of the 5 who always follow the curb, and 3 out of the 4 who always keep to the right.

How strong is the dislike of open spaces, where there is no wall, fence, etc., to follow, emerges in Question No. 7. Whether the wall is followed mainly by stick or by hearing is not easy to assess. Certainly, with the 16 "carriers" it is hearing (except perhaps for the 4 with a "little vision"); for the 15 who stipulate a wall of sufficient height, it is hearing; but for the 72 who use the stick to touch the wall (Question 2) and for the 28 in Question 10 who thus keep on course, it is the stick that is important. Obviously both are used, depending on height, density, noise level, familiarity, and many other things. It happens that the order of preference is the same for both, which is scarcely surprising, but it does mean that one is often at a double disadvantage - or a double advantage.

Question No. 4

Do you usually keep towards the inside of the pavement, or more towards the outside, following the curb?

Most people keep to the inside, or towards the inside [71]. Usually this means about "18 inches" or a "body width" from the actual wall, to avoid jutting steps or gateposts, people, or obstacles against the wall. Where obstructions near the wall are expected or feared, this distance is increased, so that one is walking for a while virtually in the middle of the footway. Nine people keep to the middle of the pavement more or less all the time, 5 follow the curb, 10 follow wall or curb according to whichever is the least obstructed, 4 always keep to the right, and 1 person always keeps to the left.

Of the 9 who keep to the middle, 3 have a "little vision" and 2 perception of light. Otherwise, there is nothing in age, now or at blindness, to mark out those who keep to the middle, those who follow the curb, or those who vary, as distinct groups in any way. The last group will leave the wall and take to the curb "in busy areas," "where the building line is broken or irregular," "when there is a grass verge and no posts," "in the village," "where it is most convenient," etc. Thus, one moves to the pavement edge in towns to avoid possible obstacles on the pavement, whereas another moves in to the wall to avoid the posts. The difference between these 29 and the majority almost certainly lies in the areas in which they move. While most local authorities, for instance, site lamp posts, trees, etc., near the curb there are unfortunate exceptions where such things are placed near the wall, in the middle of the pavement, or alternately near curb and wall. No satisfactory explanation is offered as to why people should keep always to the right or the left. This could be a help in some places like New Zealand, where apparently people keep to the left in busy streets, but one would think that generally this is to sample the worst of "both worlds," since one is bound to negotiate the mos obstructed side of the pavement, either going or returning.

Within the principle of "least resistance" (fewest obstacl the wall is easier to follow than the curb, as it can usually b heard, and there is not the same danger of stepping, or being i advertently elbowed, into the road.

Question No. 5

If you are ever out alone, without a stick, how do you get on, how does it feel?

Forty-three never, "never subject self to such an experien 2 do not have a stick; of the remaining 55, 21 appear to manage reasonably well, particularly in familiar surroundings, and 34 fare less well. This division is, of course, deplorably arbitr and may at times only reflect the degree of discomfort a person willing to *admit* to, although most of the replies were very fra and objective.

Not surprisingly, the 21 who manage fairly well include 10 those whose stick is mainly carried anyhow; 2 more never used t use a stick. These subjects are generally among the younger pe ple (average age now 41.12) who lost their sight quite early(2. The 34 who find greater difficulty are slightly older (45.64) a blindness occurred somewhat later (13.29). Those who have neve been so bold or so unfortunate are again slightly older (47.72) and blind a little later (18.3). Table 7 shows how people clai to manage without a stick, divided according to age at which blindness occurred. It will be seen that those blind before ag 10 are divided more or less equally between the three categorie but that after age 10 (7 in actual fact) there are no more entr in the column of those managing quite well. Those becoming bli between 10 and 50 are roughly divided between "manage not so we and "never," and after 50 all entries appear in the "never" col

Even those who manage quite well specify familiar surround- ings, not too much noise, not too many obstacles, and good (qui weather conditions. Without one's stick, "wand," or "cudgel" o does not feel very comfortable: 14 have no confidence, 13 must go slow or slower, 8 feel lost, 4 afraid, and 4 insecure. One might resort to touching the wall with the hand [7] or to using stick substitute, a rolled-up newspaper, brief case, or the lar est portion of a stick that had broken. Other adjectives are: "unprotected," "peculiar," "strange," "awful," "dreadful," "un- pleasant," "undressed," "naked." Even those who used to manage perfectly well without a stick find it strange now to be withou and lack confidence. The use of a stick, it seems, "grows on y like reading spectacles."

Perhaps I may be permitted a personal digression here, fro my own experience At the two schools for the blind of which I

TABLE 7

SELF-RATINGS OF NAVIGATIONAL SUCCESS (NO STICK)

	Manage without stick		
Age at onset of blindness	Quite well	Not so well	Never
Birth to 5	14	12	16
5 to 10	3	5	4
10 to 20	0	5	7
20 to 30	0	4	3
30 to 40	0	2	6
40 to 50	0	3	2
50 to 60	0	0	3
60 to 65	0	0	2

(Nine people have been omitted: 2 no stick, 4 age at blindness unstated, 3 too much vision for valid inclusion.)

have any personal experience, none of the pupils used a stick. To use a stick would have been incredibly infra dig. and, indeed, we definitely managed well enough without. (I understand that use of a stick is now encouraged.) However, I doubt if one could find many expupils who do not now use either a stick or a quide dog and would feel very ill at ease without. Quite apart from the question of how fair this was to the public at large, I believe that getting around busy streets without a stick was often a very great strain, and sometimes involved moving along in a slow and hesitant fashion perhaps with elbow raised to fend off an anticipated collision. From time to time mishaps occurred, which a stick would often have averted.

I would suggest that, having later adopted a stick, most of us have found this a relief and our traveling that bit easier and safer. It may be that each new mishap leaves its dint in one's confidence, as well as one's carcass, so that one is more prepared to use a stick later on. This is surely given added necessity by the fact that several of the places to which school-leavers might go for training are in or near Central London. One also moves from an environment in which a stick is definitely not "the done thing" into one where its nonuse is more likely to attract comment.

Question No. 6

What weather conditions (not necessarily those which do, or even could, occur together) do you find the most trying from the point of view of getting around?

The table below shows the number of people who mentioned a particular feature of the weather as trying, and also the number of people who put that particular item first in their list, as being the worst.

TABLE 8

WEATHER CONDITIONS IMPEDING MOBILITY

Weather conditions	Mentioned	No. of times considered most trying
Snow	79	42
Wind	76	41
Rain	33	4
Ice	22	6
Fog	9	3
Sun	8	5

Snow

Snow deadens sound, covers landmarks - particularly curbs, so that it is possible to wander off the pavement and on to the road. It is slippery, of course, and is awkward to negotiate where it has formed drifts or has been swept up into heaps (when such heaps are built up at random on the pavement, some by the wall, some by the curb, an ordinarily straight pavement can become a complicated labyrinth). Many people add that the snow must be "deep," "thick," "over 4 inches" before it becomes a real nuisance.

Wind

Wind makes hearing difficult, both by disturbing existing patterns of sound and by creating additional noise, particularly in trees, which mask more useful sounds. Wind is particularly trying "if it is blowing against the direction I am going." All the extra noise and the disturbance of existing sounds, "disturbs orientation," "upsets balance," "limits the spatial horizon," "makes me lose my bearings." (It should be remarked that many people say of noise, in another context, that it causes them to lose their bearings.) Wind is usually qualified as "strong," "high," "rough."

Rain

Again the problem is noise, especially the increased noise made by the traffic swishing over the wet roads. There is also, of course, discomfort. This is particularly the case for blind travelers, since several report that to wear any kind of hat or covering against the rain interferes with the limited use of the hearing that is still possible. Some feel that the rain, or the discomfort, make it more difficult to concentrate on one's journey. When it is raining there are few other pedestrians to offer any help, since people naturally tend to travel by public transport or by car and avoid walking; those few people that are about are in a hurry to get out of the rain, which further diminishes the probability of any help, while increasing the chance of colliding with anyone who has not noted their approach. Encounters with raised umbrellas can be especially painful, should the fringe of spikes be about eye level. The menace of wet hedges has already been mentioned in Question 3. A combination of wind and rain is mentioned by a number of people as being decidedly the worst possible type of weather for getting about in.

Ice

The danger of treading on a patch of ice, perhaps resulting in a fall, is obviously increased when one cannot see that it is there. On the other hand, it may well be that a blind person compensates for this to some extent, walking more carefully in icy weather, simply because he can not be sure that a patch of ice is *not* there. Nevertheless, icy conditions are still disagreeable however the performance of the blind compares with that of the seeing. It might be thought that those mentioning ice would be found to be the more elderly subjects. In fact, 12 of the 22 are of older-than-average age, and the rest average or below.

Fog

It is generally thought that fog, like the war time blackouts, leaves blind people unaffected while causing difficulty for the seeing. However, blind travelers also dislike fog on two counts. First the danger from other pedestrians, and more seriously, from vehicles, is increased because "people will not see me," "drivers may fail to see me." Second, a very few find that fog has a damping effect on sound, and also "fills up the gaps between the houses, so that I do not hear the ends of the streets as I pass." These difficulties seem to be felt by only a few people, and to many blind people the lack of traffic and the general quietness are distinct advantages of foggy weather.

Sun

Six of the 8 who mention sun, "bright sun," "sun in my face," have either a little vision or perception of light. For them, the glare is dazzling, confusing, "blots me out." Another dislikes walking on warm sunny days because he finds that on such days the pavements tend to be most cluttered up with obstacles of all kinds. The eighth subject gives no reason.

Subjects putting snow as the worst weather were compared with those putting wind as worst, to see if any differences existed as to age at blindness or age now. Thus, it might be that snow which covers landmarks, makes use of the stick more difficult, and is apt to be slippery, would be more disliked by the subjects who are older and became blind later. On the other hand, wind which only affects sound, might be more disliked by the younger subjects, the early blind, who appear to rely more on reflected sound. No such differences can be found, either as to age now or age at blindness. Clearly the above is an oversimplification of the situation.

It may be as well to point out at this stage that there is a certain link between age now and age at blindness, for the subjects in this sample. Those covered by the term "early blind" as defined in the Introduction have an average age of 45.29, as against the 56.68 of the "late blind"; 67 percent of the early blind are below the age of 50, compared with 24 percent of the late blind. Anything correlating with age at blindness therefore tends to correlate with present age also. Fortunately, the correlation between present age and age at blindness is limited; beyond present age 50, it is possible to distinguish two closely matching groups, in which the subjects are equated for age now but differentiated by age at blindness. Approximately 42 percent of the sample are aged 50 or above. It is usually possible, therefore, to form an opinion as to which factor (if either) has any connection with a given phenomenon, age now or age at blindness.

Question No. 7

Given reasonable weather conditions, what sort of places do you find awkward to negotiate? Perhaps you would care to list several, in order of decreasing difficulty, and to add a few thoughts on the origins of the difficulties.

Nineteen specifically mentioned shopping centers and busy streets; 18 listed railway stations (both surface and underground); 17 sudden slopes or flights of downward steps (this is mentioned equally by old and young, although one might perhaps have expected it to be particularly associated with the elderly); 8 wide roads, "wide crossings"; 6 uneven, bumpy ground; and 6 post-war housing estates. Car parks are mentioned by many as a specially awkward type of open space, since they may contain a

TABLE 9

ENVIRONMENTS JUDGED DIFFICULT TO NAVIGATE

Type of environment	Number of times mentioned	Order of difficulty: First	Second	Third
Open spaces	60	31	25	4
Noisy places	35	21	12	2
Busy, crowded places	30	12	11	7

number of stationary vehicles and also vehicles maneuvering into position or backing.

The following are each mentioned by one or two people: busy road junctions; sideroads debouching into another road in the form of an "estuary," or with the corners so angled that it is difficult to cross straight; crossroads which are "offset" so that to cross straight ahead takes you not on to the continuation of the pavement, but into the road (the same danger as the angled corners); stretches of grass which are "silent" underfoot; open manholes; double curbs; one-way streets, because these are harder to cross as drivers are less inclined to stop; freshly graveled roads (also beaches), because echoes are "fragmented" and the auditory cues so disturbed that it is difficult to get about; tarred pavements, because those with a little sight cannot tell where the pavement ends and the road begins; the modern type of high platform pavement is trying because of the chance of walking off the side; the noise of building work, and attendant changes to the topography, barriers, hoardings, etc.

Open spaces

At first glance it might seem a little curious that open spaces should be so unpopular. It might be thought that an open space would be actually welcomed by the blind traveler. The difficulty is twofold. First, with no wall to follow, either by stick or sound, there is the likelihood of not going straight, and perhaps of getting rather lost. This may be compared to the sighted traveler in extremely dense fog, when all surrounding landmarks have disappeared. Second, open spaces are not usually simply "spaces," but car parks, parks or gardens, courtyards or forecourts to modern housing developments, with vehicles, seats, low decorative walls, fences, hedges, or flower beds, ornamental features too low to be easily heard and probably arranged in patterns which make pathways rather complicated, however pleasant to the eye the general effect may be. It is quite possible to lose a field path, having inadvertently strayed off it. In more built-up areas, one may "lose the sense of direction" and wander off the pavement in open spaces where there is "no guidance." It is interesting that 80 percent of those who feel that they walk in a straight line, even with no wall to follow, still dislike open spaces.

Noisy places

The disadvantages of a great deal of noise, obliterating the sounds upon which one is relying for guidance and for warning of obstacles, is obvious enough. Several people also find that excessive noise has a disorienting effect. Presumably, one reason why noisy surroundings are not mentioned as frequently as open spaces is that one still is able to follow walls with the stick, however apprehensively.

Crowded places

It is a little surprising that crowded, busy places are not mentioned more often. Two contrasting reasons might account for this. Such places may often have been in the minds of those disliking "noisy places," and, in many ways, a really crowded street is easier to negotiate than one slightly less crowded. One correspondent puts it "I do not particularly mind streets which are densely crowded, you just go with the tide, more or less touching the person in front." The habit of keeping left in such busy areas in New Zealand shopping centers has already been referred to.

Stations

These combine many of the worst features of the above. They are noisy, open, no guidance, there is the fear of walking off the platform (particularly with electrified lines), or down the many flights of steps. Some obstacles, such as seats and the pillars supporting the roof, are always in the same places (not that one gets the chance to learn their situation very well), but others, such as trolleys and piles of luggage, can crop up in all sorts of places. Often, of course, stations are also crowded.

Shopping centers:

These are noisy and crowded with people standing about "daydreaming," absorbed in window-gazing or in queues; goods may be arranged on the pavement for display; and the partially sighted cannot tell whether glass doors are open or shut. With large stores it may also be hard to remember the layout, and which counter sells what item. Curiously enough, nobody refers to self-service stores, which present formidable problems.

The difficulties of open spaces are mentioned by both early blind and late blind about equally. But, whereas half the early blind refer to noisy places, only 3 of the 25 late blind mention this difficulty. There is the impression that their answers are much more concerned with steps, crossings, and crowded places.

Question No. 8

Remembering that this is all confidential, and that no names will be mentioned, would you say that you get all the help you want in getting about, or that you get rather more help than you want, or that sufficient help is forthcoming, but of the wrong kind? Any other comments?

Eighty-five out of the 100 state that they generally get enough, "sufficient," "plenty" help; 15 not enough. Of these 15, 1 does not carry a stick, 1 travels at rush hours, 3 get help of the wrong kind, 1 "not always enough with crossing roads," and 1 "from friends, yes, from the general public, no." The remaining 8: just not enough. Two of these find "1 person in 10 helpful," another that "the more I need, the less I get."

Five feel that children are the most helpful; 1 that teen-agers are; 1 car drivers; 1 the elderly; and 3 feel that men are the the most helpful. Six say that there is very little help a-vailable in rain or bad weather, and 2 that there is very little during rush hours. Others find that there is "less in larger towns," "less outside one's own locality," "most in South Wales, London, and the West Country, very little in the west Midlands," "too much in emergent countries, just as you want in Germany and other European countries."

Among the 85 who generally get all the help they need, 12 sometimes do not get enough, and 11 sometimes too much. At least 24 people say that the help they get is sometimes "rough," "tact-less," or "misplaced." There are constant references to being "lifted" on or off buses, being virtually "carried" along a road, and being "manhandled in a manner which is dangerous, uncomfort-able, and undignified." It is acutely embarrassing to be guided to a seat with someone heaving on each arm, and impossible to sit down when you get there. Many people refer to being "pushed" along, rather than led. On the other hand, a few people have had the unpleasant experience of the helper who goes to the opposite extreme, walking along a few feet behind, or to the side, giving you a "walking commentary": "left a bit, right, carry on, yes, keep on like that, whoa! left a bit," etc. The strain of avoid-ing the helper, on top of his overanxiety, is considerable.

Seven subjects make the point that "you must know exactly where you want to go" and that you "must ask"; 4 say "the amount of help I get depends on me" and "my mood"; and 6 feel that people are "nervous," "shy," or "apprehensive" about offering to help.

Some helpers are in fact so nervous that their well-intentioned helping constitutes something of a strain.

Further instances of the wrong kind of help are as follows. Straying rather towards the edge of the pavement, one may be seized and whisked across the road, or even on to a nearby bus! "Do you want this bus?" By the time one has asked the number of "this bus," it has gone. A helpful person takes you across the road, but abandons the job halfway, saying "You'll be all right now." Perhaps you are waiting to cross, when a loud shout from down the road is heard; is the shout intended for you, and if so, does it mean "cross" or "don't cross"? It is next to impossible to "alight" from a bus with someone holding you up so that you cannot get a foot down to the ground.

Many people welcome the helper who offers an arm, neither pushing you along nor operating you by remote control. It is usually far easier for a blind person if he or she can take your arm, because he can then follow your movements. Being just an inch or two behind, he can know, from your own movements, that a step up or down is coming, or a turn to left or right. If, on the other hand, you take *his* arm, then he is the one in front, with no guidance, and a good deal more active guiding by voice and arm will be necessary. A few subjects put great stress on "the kind of inconspicuous help given by people who can put themselves in your place."

There seem to be a few blind people who make what I have called elsewhere a "fetish" of "independence." It would appear that such people refuse all offers of help, sometimes very curtly, and are supposed to account very largely for the diffidence which members of the public often express about offering to help other blind people. Those in this survey have much to say by way of condemning such "independent" behavior, and it is pointed out that even the pedestrain who steps aside to let you pass is helping, whether you like it or not. Almost every one of the 100 says that he or she accepts gratefully any offered help, even when this may be unnecessary, because to refuse might be to dissuade the helper from assisting other blind people at times when the help was more necessary. In any case, the assistance provides a breathing space in which to relax a little before tackling the next stage of the journey. It also provides a welcome opportunity for meeting people, and many interesting conversations and sometimes friendships have come about in this way.

It would be misleading to leave the impression that the blind are overcritical of the helpfulness of the general public. The question called for criticisms, and that is what the answers provided. But very few of the answers did not also include a good deal of honest gratitude for the amount of help that is given, and much praise of those who give it. Perhaps the main reason for putting on record the criticisms is that, as several people pointed out, it is difficult if not impossible to tell someone who has gone out of his way to give you a helping hand that he is doing it wrongly. Several subjects add the comment that should the situations be reversed we ourselves should probably do much the same.

Question No. 9

Is it your impression that you "naturally" walk in a straight line, or that keeping on course demands a conscious effort to correct a tendency to veer off?

Forty-seven people veer; 9 think that they veer; 23 feel that they can keep straight with an effort; 20 that they walk straight without any effort. The 20 include 3 with a little vision, an "exarmy man," 9 blind from birth, 5 blind from childhood, and 2 from their teens.

Of those people who do veer; 9 veer right; 5 left; 5 towards the curb; 5 towards the side of a deaf ear; 2 will veer after carrying anything heavy; 2 when crossing the top of a slope; 4 when in noise; 4 veer even with effort; 3 feel the tendency becomes worse with concentration; and 1 will "veer if people are watching." One goes left through being left handed, another veers right for the same reason. One does not walk straight "partly due to being lightweight." Three subjects feel that it is impossible for anyone, blind or sighted, to walk in a straight line, 15 say they cannot do so without a wall to follow, 2 need landmarks, and 1 the gaps between paving stones. Three people feel that the faster they walk the less they veer, and 1 that his keeping a straight line is "much improved through experience with a dog."

The ability to keep a straight course, either "naturally" or with an effort, does seem to occur more often among those becoming blind early (see Table 10). The high proportion of the 20 to 30's claiming such ability is rather striking, but it is not easy to account for it. If we take the present ages of those who walk straight the high proportion of the 30 to 40's with this ability is probably the most noticeable feature (Table 11). It is difficult to see any clear relationship between ability to keep on course and present age.

Question No. 10

Would you be prepared to say that, when it comes to getting about, hearing and the use of a stick do essentially the same job, the stick simply supplying information for the hearing to use? Or would you say that the two have different parts to play, that the stick takes care of some things and hearing of other things? If so, what functions would you assign to each of them, forgetting for the moment that the color of the stick has any significance?

Twenty-eight use the stick for guidance, course, "showing the

TABLE 10

ABILITY TO MAINTAIN A STRAIGHT LINE: AGE OF ONSET OF BLINDNESS

Age at onset of blindness	Total number of subjects	Number able to maintain straight line
Birth to 10	59	27
10 to 20	12	4
20 to 30	7	6
30 to 40	8	2
40 to 50	5	1
50 to 60	3	0
60 to 65	2	1

TABLE 11

ABILITY TO MAINTAIN A STRAIGHT LINE: PRESENT AGE

Present age	Total number of subjects	Number able to maintain straight line
10 to 20	3	2
20 to 30	10	4
30 to 40	20	14
40 to 50	20	6
50 to 60	19	8
60 to 70	18	2
70 to 75	5	2

way" (this is probably implied by many more, compare the 72 of Question 2 who use the stick to follow the wall); 17 use the stick to feel, probe, as an extension of the arm; 7 to check information already supplied by ears; 28 for detection of obstacles and protection against them; 16 for coping with low obstacles near the ground; and 17 use the stick for locating steps and curbs (again, this is an obviously low figure).

Twelve find a connection between the stick and hearing, inasmuch as the stick is used to produce echoes for the ear to use; 6 find no such connection. Five of the 6 are late blind (the sixth age of blindness was not stated), and 10 of the 12 are early blind, plus 1 unknown and 1 late. All 7 of those who feel that the stick is used to check things heard are early blind.

The stick is, of course, the more reliable in noisy surroundings [5], and is used for the "immediate," "intimate," "nearby," and for "detail" [9].

Hearing is used by 22 in traffic (besides the question of crossing roads, traffic noise tells you that you are coming to an intersection, while too much or too little traffic may let you know that you have taken a wrong turning); 17 use echoes, from stick or otherwise; 16 for approaching people; 16 for "more distant," or the "general" scene; and 11 for locating obstacles. It is the early blind who are concerned with hearing echoes and hearing obstacles, the late blind are more inclined to mention traffic and approaching pedestrians. No one becoming blind later than 38 mentions using hearing for obstacles or echoes, and it may be worth recalling that no one becoming blind later than 40 preferred noisy shoes.

Fourteen stress the greater importance of hearing; all are early blind. For them hearing is the real guide, the stick merely a protection against collisions. Not surprisingly, 6 of these mainly carry their stick, 1 does not have a stick. Presumably the rest of the "carriers," minus those with a little vision, could also be added, making about one-fifth of the total sample who thus emphasize hearing.

Approximately two-thirds of the 100 answers to this question embody some form of the idea that the stick is used for the things in the immediate vicinity, particularly those things too low to be heard, while hearing is used for things outside this area. This must, of course, be so because of the limited length of the stick. One could distinguish a third area, larger than that within the reach of the stick but still very limited, the area within which people are able to make use of sound reflections as against sound emanations. Sampling the environment with a stick is a relatively slow, discontinuous process, and one could only get along at a tedious pace if one could not also make use of more long range sampling through sound. However, sound cues, both reflected and from source, are affected by a number of things such as weather conditions, noise level, etc., and are altogether less reliable than use of the stick. Obstacles may be too low, to thin, or too insubstantial to give a "good echo." Thus, for most blind people neither stick nor hearing is sufficient for mobility without the other. One wants a combination of the speed and continuity of hearing and the reliability of the stick.

Question No. 11

Do you think that you use your hearing more or less when getting about indoors, as compared with walking outdoors?

It is felt by 73 that they make less use of hearing when moving about indoors; 15 say equal, or "not sure," or "don't know" 5 think more. (Several have not answered the question.)

The 5 "mores" do not seem to be distinguished by age, now or at blindness; 3 are evidently thinking of the greater absorption of sound indoors by furnishings and carpets, and hence that hearing would need to be used more under these more difficult conditions. The remaining 2 have in mind the greater quietness indoors and the added possibilities for using one's hearing. Similarly, nothing marks off those "equally" and "not sure" from the rest. At least 3 of them live in very large buildings, and quite a number of people point out that, although they feel that hearing is used far less in the home, where a large building is concerned such as one's place of work, the hearing may be used just about as much as when traveling out of doors. However, this still leave 12 unaccounted for.

Indoors - the home - is familiar; there are fewer hazards (particularly if one lives alone, with nobody else to move things about); there are no "moving" objects to beware of; altogether, one can afford to pay less attention to one's walking, so much so that more than one person mentions walking into a closed door on occasions when busy thinking. Instead of concentrating on auditory cues, one uses "touch," "sense of direction," "muscular memory of landmarks," "estimation of angles," "spatial memory," "conditioned reflexes." "Knowing the geography, I just steam ahead." "Indoors I use my hearing more or less as when sighted, outdoors sounds have to be analyzed and memorized according to the danger they signal." "Distances are so much smaller indoors that you can handle them and know them in a way that you cannot with those outside."

It seems that indoors, with smaller distances and few changes in the setting of obstacles, one relies almost exclusively on memory rather than hearing. There are also changes in the surface underfoot which may be helpful. An interesting illustration is given in one answer of what happens when memory dominates perception: "Recently, at my place of work, a door, which was for years left half-open and projecting into a small room, was completely removed. For weeks afterwards I found myself walking round the area formerly occupied by the door; in fact, it almost hurt to walk quickly into the hitherto unused area, because the memories of the former pattern of the room were so strong."

One answer adds a touch of caution to what has been said. The writer concludes that he must use his hearing indoors rather more than he thought since, when his hearing was temporarily impaired, he found himself walking into things.

Question No. 12

What is your own private theory about this "sixth sense" which is supposed to warn blind people of nearby obstacles?

Sixteen people accept that there is such a "sixth sense"; 30 think it is nothing more nor less than acute hearing or ordinary hearing more closely attended to; 17 think hearing plus some other form of sensation; 23 put the warning down to the use of the "other senses" ("other" than the "sixth sense"); 8 do not believe in the existence of a "sixth sense", but have no explanation to suggest; the remaining 6 state that they have "no theory," without making it plain whether they believe in a "sixth sense" or reject it.

Hearing is mentioned, plus: "some sensitivity which is strongest around cheecks and temples"; "a feeling of density from an object"; "skin perception"; "touch"; "smell and touch"; "sensations in the forehead." A number of people refer to the temples as the location of this sensitivity. A mechanism is suggested through which the auditory and cutaneous components have become associated. Thus it is supposed that in the past the echo from an object has been quickly followed by actual physical contact with that object, and that when later the echo of a nearby object is perceived, this tends to evoke contact sensations in the skin. This theory of the origin of the facial sensations is the same as that proposed by Dolanski (1), in which he describes such sensations as a fear response, analogous to gooseflesh or the bristling of animals. These sensations occur even with the relevant areas of the skin covered, so long as sound can get to the ears. Without sound no facial response occurs even when an object is brought near the skin. If a device known as a "pseudophone" is used, which effectually reverses the two ears so that a sound actually to one's left is heard as coming from the right, the skin sensations move with the sound. That is to say, the facial sensations occur on that side of the face furthest from the object.

A very few think that this is a "danger sense," common to everyone, but possibly enhanced in the blind; others think that only *some* people have this warning sense. Five people invoke a connection with air pressure: "the direction and force of air currents, which are deflected by nearby objects"; "increasing air pressure between self and large objects as one approaches"; "air currents round objects." Two answers make use of temperature sensitivity, although it is not clear whether the writers are thinking of heat reflected from objects or of shadows (see Question 15).

Turning again to the people who accept a "sixth sense," belief is most common among those over 60 irrespective of age at blindness. About one-third of the over-60's and even more of the over-70's subscribe to the belief, compared to less than one-sixteenth of those aged 30 to 60.

There can be no doubt that the basis of this obstacle detection is auditory. Both the experiences of blind people and the results of numerous scientific experiments concur on this point. Many who would have been satisfied with this explanation have been reluctant to accept it wholeheartedly as it failed to account for the facial sensations which, however caused, are nevertheless real enough to the percipient. These have already been referred to above and need not constitute a "red herring" any longer. It may be noted here that of the 11 people in this survey suffering from some degree of hearing impairment, those 5 with the least impairment are still able to detect objects by reflected sound. Again, the most impaired of the 5 is the worst at object detection. The ability is for some subjects absent on the side of a deaf ear, although they can detect objects on the side of the "good" ear. One person remembers that her ability to detect obstacles "declined along with my hearing," and reference has already been made to the man who finds himself bumping into things when his hearing is temporarily impaired by catarrh.

It seems clear that factors other than hearing can play a part in this on occasions. The sense of smell may be useful in a very few instances when the smell of timber, or freshly turned earth, or the paraffin that is used for the warning lamps around roadworks causes one to tread warily. Or one may be able to detect the sudden shadow as a nearby object comes between face and sunshine. The same thing may apply when a wind is blowing; a sudden rush or wind may signal the space between buildings, while any large obstacle may act as a momentary shield against the wind.

The cues that one uses are often so minute that even the blind person is not aware of just how he senses the presence of an obstacle. One should not be too surprised that the idea of a "sixth sense" grew up, but it is now mostly superseded.

Question No. 13

Among the common obstacles to be met with outdoors, which do you find to be the greatest menace, and why?

The following is a list - not exhaustive by any means - of those obstacles which people find most trying, in order of most mentioned to those mentioned by only one or two people.

Bicycle - 40: Propped against wall or curb or fallen, undetectable by hearing, they are easily missed by the stick, and a nasty knock can result; they invariably fall over when touched and can be very difficult to stand up again; they can occur almost anywhere, any time. (When moving they are also disliked because their silent approach gives no warning.)

Roadworks - 32: Again undetectable, when work is not in progress; when working, noise of drills, compressors, rams, etc; holes to fall down, mounds to fall over or to force a detour into the road; barriers, often insubstantial and low, so that instead of removing danger they add the risk of tripping. Some rope barriers allow so much slack that it is still possible to slither into an excavation. There is also the general paraphernalia of lamps, tools, etc. The whole set-up may have appeared overnight and disappear just as suddenly.

Posts - 24: These are almost always qualified as "thin posts," "awkwardly placed," "in the middle of the pavement." Again, "thin" posts are virtually undetectable; as long as they are confined to the edge of the pavement this hardly matters, but becomes serious when they occur elsewhere.

Prams - 21: Too low to be easily detected; some people "use them to batter their way through"; danger of startling the occupant, or even of tipping the baby out.

Toys - 19: Low, undetectable.

Ladders - 16: Thin, undetectable; danger of causing accident to anyone working on the ladder.

Scaffolding - 14: Thin, undetectable; temporary.

Overhanging branches, awnings, etc. - 11

Tricycles - 10

Children - 8: Either playing on the pavement, when their movements are "erratic and unpredictable," or standing staring at "the funny blind man" and forgetting to move out of his way until too late. "It happened to me once...I hope I never feel so awful again."

Dogs - 7: Lying about on the pavement, stirred into life by a chance poke with the stick.

Dustbins - 6

Scooters - 5

Garages - 5: No wall or curb to follow, for the moment; the danger of cars coming in and out across the pavement.

Jutting steps - 5: Undetectable, tripping.

Daydreamers - 4

Advertisement signs - 4

Seats or benches - 4

Goods displayed on the pavement - 4

Traffic signs - 3

Open car doors - 3

Vehicles parked partly on the pavement - 3

Trees - 2

Bus shelters - 2

Parking meters - 2

Pushchairs - 2

Barrows

Outward opening gates

Umbrellas

Cows waiting to be milked

Open coal holes

Open beer chutes

The emphasis of the replies is on "movable," "temporary," or "impermanent" obstacles. These present difficulty because by their very nature their position cannot be learned for future avoidance. Thus, along a certain road a bicycle may be propped against the wall by the gate of house perhaps once in three weeks, but one must still beware of it every day that one uses that road. Roadworks, scaffolding, ladders, may suddenly appear on what has hitherto been a stretch of empty pavement. There is nothing predictable about these things; one day the way is clear, the next time you pass you find that it isn't; and the next time...? If an obstacle is always there you can learn to avoid it. Unfortunately, such temporary obstacles are also usually of a reasonably light, portable structure which does not reflect sound particularly well. Thus, there are only very few people who find difficulty with vehicles partly parked on the pavement; most people can detect such large objects, but a bicycle or pram is a different story. A fence would be detected where the barrier around roadworks is not.

Detectability of temporary or permanent obstacles also depends on size. "Thin" things which do not present a very large surface, such as some posts and trees, ladders, scaffolding, are virtually undetectable by ear and are particularly easy to miss with the stick. On the other hand, things which may be wide but are too low, below "waist," ear," "eye" level, below "3 feet, 6 inches," "less high than myself," are also impossible to detect by ear although they may be located by the stick. This was one of the prime uses of the stick mentioned in Question 10. (Compare also the remarks about height in Question 3.) It is noteworthy that of the 37 who mention low things or things that are too low to hear, 34 are early blind.

A third feature of the obstacles mentioned is the fear of tripping or falling. Thus, there are plenty of references to holes (roadworks); downward flights of steps; bumpy or uneven ground; patches of ice; falling off station platforms, double curbs, or into open manholes, coal holes, or chutes. Whenever these figures have been analyzed, as with the steps and the ice, it is found that such fears occur among those of all ages and are not, as might be thought, particularly found among the more elderly. Such pitfalls are the more feared because they cannot be detected in advance by the ears and are not likely to be found by the stick unless one is searching for such dangers.

In the Introduction reference was made to the study by the Haskins Laboratories, New York, from which it emerged that the blind people questioned were "primarily concerned with the harmfulness of an encounter, rather than with the frequency with which an object is met." Thus, open manholes or doors to cellars are items in the most disagreeable group, along with station platforms and, strangely enough, "mailboxes." In the second group one finds poles, half-open doors, curbs, pipes, ropes, stairs, and awnings at head level. The third group contains "stands in the street," sawhorses, hydrants, and half-open drawers. In the final group are refuse boxes, subway turnstiles, small tables, chairs, and footstools. The present findings seem to agree with the Haskins results on one point: things that might cause one to fall come at or near the top, taking into account all those just listed and dealt with in other questions. But beyond this it is difficult to see the way clear. In terms of painfulness of the encounter, why should ladders be mentioned eight times as often as trees, or children twice as often as daydreamers? Why should toys feature so prominently? Are they more painful than seats, more easily tripped over than pushchairs?

I cannot help feeling that the situation is vastly more complicated than the American study suggests. At least eight points have to be borne in mind it seems to me, when considering the disagreeableness of obstacles, resulting in such a complex relationship that any attempt to arrange obstacles in order of difficulty will probably be fruitless.

1) Undetectability: Clearly this is a prerequisite of any obstacle presenting difficulty.

2) Frequency
and
3) Painfulness: Perhaps these two should be multiplied to measure the product. Obviously, nonpainful obstacles, however frequent, would not matter very much nor, within limits, would a painful obstacle which was scarecely ever met with.

4) Self-consciousness: This can on occasions constitute the major threat from an obstacle - the bicycle which crashes to the ground and will not stand up again while several sympathetic spectators gather round; the precarious pile of goods outside the shop which scatter over the pavement as someone brushes against them. For many blind people a collision with any obstacle may arouse feelings of acute self-consciousness and some embarrassment should other pedestrians witness the mishap. One does not seek to be conspicuous (see Question 20).

5) Danger to Others or to Property: Clearly this comes into the dislike of prams and of ladders and goods on the pavement. This is a primary consideration where children, and perhaps their toys, are involved.

6) Attended or Unattended Obstacles: Obviously, prams, pushchairs, and bicycles tend to be less of a menace (usually) when being wheeled than when stationary; someone engaged in unloading goods from a vehicle or on road repairs will often see the blind person safely past the hazard.

7) Predictability: Obstacles that are likely to appear because of time, place, or weather, can be "watched for." Even the ability to detect obstacles is, according to several people, enhanced by expectation. This is obviously the case with the stick and the way one uses it.

8) Past Experience: Quite apart from the question of knowing an area and the obstacles in it, it is noticeable that in several cases people report having a fear, almost a phobia, of some particular danger through an unfortunate previous experience. One person has a great fear of station platforms, having once fallen on to the line; another of posts, having once collided with one which had a projecting screw at forehead height. Such experiences probably override all the other considerations listed.

Question No. 14

Some blind people can detect obstacles at quite surprising distances, others are not so lucky. What sort of obstacles do you yourself find detectable, and at what distances, roughly?

Seventy-four people can detect obstacles (by echo); 5 are dubious; 5 have a little vision, which cannot be ruled out; 2 give rather evasive answers; 14 cannot. Of the 45 people blind before age 5, 40 have this ability (2 have some sight, 2 more are dubious, and the 45th cannot); 62 of the 71 blind before age 20 can detect things (2 more are "dubious," 2 more "cannot"); among those becoming blind later, 11 can detect obstacles by echo while 11 cannot. There is nothing to distinguish the 11 who can from those who cannot, in age now, at blindness, or length of blindness. It is found, however, that 6 of the 14 "cannot"s have some hearing deficiency.

The following are some of the more common obstacles that are detected, together with the rough estimates of distance, given quiet conditions:

Car: 20, 15, 15 to 10, 10, 9 to 6, 9 to 6, 6, 6, 6, 6, 6, 6, 4, 3, 3, 3 to 2, 2, 2, 2, "few steps," "easy," "fairly easy," "at the other side of a narrow road," "few yards"

Posts: 18, 15 to 12, 12 to 9, 10, 9, 6, 6, 6, 6 to 4, 6 to 3, 5, 5 to 3, 4, 4, 3, 3, 3 to 2, 2 to 1, "as pass"

Wall: 75 to 60, 30, 30, 15, 15, 15 to 12, 12, 7 to 6, 6, 5 to 4, 3, 3, 3 to 2, "few yards," "other side of road," "few paces"

Parked truck or large van: 20, 18, 12

Tree: 30, 24, 18, 15 to 10, 15 to 10, 10, 4, 2, 2 to 1, "better than a wall or a building"

Building: 45 to 30, 22, 10 to 7, 8, 5

"Big Things": 12 to 9, 9, 3, 3, 3, "good distance," "few yards," "fairly easy."

(one person claims to be able to hear a step-up, and one, perhaps two, to detect steps down.)

To be easily detectable, 17 say objects must be large, 5 that they must be substantial enough to "give a good echo," 3 that they must reach to face level, 1 to ear level, and 4 that they must be "as tall as me." Ability is, of course, affected by amount of surrounding noise [6], and is improved by familiarity, expectation or regularity "as with the regular spacing of posts" [4]. The design of a building's facade is found to affect the range at which it is first sensed, so that a building with a projecting porch or veranda is detected several feet further away than a straight facade. At least 4 people find that objects can be detected at a greater distance when they are to the right or left than when straight ahead. One man estimates that objects to the side can be sensed at two to three times the distance. "Efficiency appears to decrease gradually as the angle to the direction of motion decreases" and also "to decrease sharply as the angle exceeds a right-angle." Two people who can sense objects to the side cannot detect things ahead at all, and many report noticing posts as they pass, although this is also, of course, their nearest approach.

Performance is better with an escort, according to one, and best with clear frosty weather, with no wind, according to several. How one is feeling is also said to have an effect; headache or "stuffiness" reduces efficiency. Concentration is a very important factor. A wall of reasonable height, by acting as a reflector, may "throw into relief" trees or posts on one's other side, but may also because of its own echo mask echoes from such obstacles between the wall and the traveler.

Is there any connection between ability to detect obstacles and age now or at blindness? Taking as a rough measure the 21 people who mention distances of 10 feet and over, we find that 17 of them became blind before age 7, the majority from birth; a further 2 became blind in their teens, and the 2 remaining do have perception of light which might or might not be helping them. As for present age, all age groups are represented, except the 70's, but there does seem to be a slightly larger proportion among the younger subjects. This seems to be what one would expect to find in view of the greater experience - and early experience - of the early blind and the decreased efficiency of hearing with advancing age.

As indicated in Question 12, 6 of the 11 with some hearing defect do not sense nearby objects, the 3 with least impairment do, and 2 do to an extent corresponding with the impairment. Also 6 of the 8 with light perception, and 2 of the 5 with "little vision," show some ability.

Question No. 15

Have you ever been quite certain that there was something in your way, only to find that there wasn't? How did you explain this illusion?

Seventy-one people answered "yes"; 26 said "no" or "never"; (1 was not sure, 2 gave no answer); "often" - 10; sometimes - 13; occasionally, very rarely - 9.

Such an illusion is variously attributed to:

"Shadows" 7: When we perceive a shadow, because of the difference in temperature between shadow and sunlight, we infer the presence of an object (2 of the 7 do have light perception, the rest not).

Lack of concentration 5

Excessive concentration 5

Overhanging branch or awning overhead 5

Changed acoustics due to the weather 5

Imagination 4

Disturbances in air pressure 4

Wind-blown echoes 4

False echoes from one's other side or caused by another person 3

Sounds coming from both sides, to both ears, simultaneously 3

Tiredness 3

Overstrain, anxiety 3

Bird overhead causing passing shaw 2

Sunlight 2

Air pocket 2

Misinterpreted echo when walking fast 2

Draught

Tension

Cloud formation

Unusual echo patterns produced by irregularities in nearby surfaces

"This happens particularly when walking on fresh gravel"; some connect it with puddles also. "Tarred pavements often cause this." "A change from a cement path to soil ahead gives the impression of a wall." "Hardly ever in good weather, frequently when windy"; "in close, heavy, weather." There are 17 subjects who say they cannot explain the illusion.

So, four types of theory are advanced, connecting such illusions with a) subjective factors, concentration, imagination, etc.; b) sound, distorted, deflected, or simultaneous echoes; c) shadows and temperature differerences; and d) air pressure, pockets, and currents. Apart from the subjective factors - presumably drawn upon to explain breakdowns of normal perception - these are the same types of explanation as those suggested for the "sixth sense" (see Question 12).

This sort of illusion is rather more common among the early blind, 79 percent of whom have experienced it, compared with 52 percent of the late blind.

Such illusions seem to occur so infrequently, when they occur at all, as to be more a subject of curiosity than a serious nuisance. Several times they are mentioned as occurring in confined spaces or alleyways, where it seems reasonable to suggest that the footsteps of someone walking more or less in the middle would be reflected back to the two ears approximately at the same time. If a sound reaches the two ears simultaneously its source will generally be assumed from experience to be equidistant from both, that is, straight ahead. Another possible explanation is that the source is immediately behind or above. This may be why, in several cases, an echo from something overhead was interpreted as an object in front. The most common place for this sort of illusion, in my own experience, is where large vehicles such as trucks with high loads are parked by the edge of the curb opposite a high wall. Subjective factors no doubt come into it, since one is presumably more apt to be deceived if fatigued or not concentrating. It also seems quite credible that one could be misled by shadow and sunlight.

The fact that the early blind appear to have more experience of such illusions may indicate the greater use they make of such cues from sound, temperature, or currents of air, or may signify nothing more than their longer experience of travel without sight.

Question No. 16

Do you usually/ever find it helpful to make some additional noise, such as clicks with the tongue or fingers, when you think there may be an obstacle but cannot be certain? If so, what sort of noise do you find the most useful?

Fifty replied "never" (very often followed by an exclamation mark) and 50 said yes. Of the 50 answering yes, 25 tap or bang the stick (certainly on the low side, most people probably not reckoning this as "additional noise"); 13 stamp, tap, or slur a shoe; 12 click their fingers; 7 click their tongues; 6 cough or clear throat loudly; 5 whistle; 3 clap; 2 sing softly; and 1 person talks to himself.

Only 3 of the 25 stick tappers are among the 17 tappers of Question 2, so that one would be safe in adding the other 14, making 39. Of the 39 people who thus use a tap of the stick, only 14 ever resort to any other sort of noise. Conversely, it would seem that of the 36 who use noises other than those of the stick, 22 do not find a tap of the stick helpful. (This may be misleading, see above.) Certainly the 25 people who tap with the stick but who would not be prepared to make any other noise do represent a large section of blind people.

It may be interesting to point out here that of the 61 people who make some kind of noise in such a situation with the stick or otherwise, 11 prefer quiet shoes even though they find sound reflections helpful. A very few state that the noise is not made for the sake of an echo, but to warn people of their approach.

Typical remarks were: "Don't think it helps" to make extra noise - 4; "too much noise in town" for it to be any use; "find extra noises helpful, but don't make any" - 3; "very occasionally in the country, never in the town"; "country and garden"; "no! try 'nerves'"; "silly 'blind' habit"; "should be thought rather mad," "slightly peculiar". Seven mention "indoors," particularly to determine whether doors are open or shut.

Here again (see Question 2 and 20) one comes up against the question of making oneself conspicuous. The majority of blind travelers find an amount of noise helpful - as long as its level is in their control. Laboratory experiments have shown that obstacle detection ability is increased 6 to 7 fold, sometimes more, when the subject has noise to help him (Kohler [6]). And yet, if people are given a fairly similar noise-producing gadget to use outside the laboratory, this is discarded fairly quickly as too conspicuous. This perfectly reasonable wish not to attract undue attention has often been overlooked by those thinking about the mobility of blind people and how this could be assisted. In an article published last year, for example, a device is described which, mounted on the head, emits noise as the wearer walks along, the returning pulses being picked up by microphones and fed to earphones (Welch [7]). One wonders if even the hardy 24 percent who do not care about conspicuousness (see Question 20) would not flinch at such a prospect! Perhaps the blind in China are less fastidious, as it appears that they carry a gong with them, which is useful both for attracting help and for its sound reflected by nearby objects. While no one could deny that such a procedure is highly conspicuous, it is easy to exaggerate the conspicuousness of a descreet finger click or snatch of quiet whistling. It is surely a moot point whether one person, suspecting the presence of an obstacle and making some little noise to reassure himself, is more or less noticeable vis-a-vis another who "waves" his stick to find out.

It is generally agreed that "higher frequency sounds" are the most helpful, also "sharp, staccato sounds." "Whistle or clap best"; "click with tongue best because it is sharp, easily made and at a better level for the ears." Laboratory studies have shown that for obstacle detection "mixed" sounds, with both high and low frequency components, and pulsed rather than continuous are the most effective. Pulses of short duration, perhaps about 0.1 sec, appear to be particularly useful (Kohler [6]).

Table 12 indicates the age at blindness and at present of those who use the stick to make additional noise and those who make other forms of noise to assist in obstacle detection. (The table totals do not tally with the figures already quoted because of the people whose ages are not known.)

TABLE 12

USE OF STICK AND OTHER SOURCES TO GENERATE SOUND CUES: AGE AT ONSET OF BLINDNESS VS. PRESENT AGE

	Subjects using stick		Subjects using other sources	
	Age at onset of blindness	Present age	Age at onset of blindness	Present age
Birth to 5	16	-	20	-
5 to 10	3	-	4	-
10 to 20	9	2	5	3
20 to 30	5	4	1	4
30 to 40	1	10	1	8
40 to 50	1	9	1	7
50 to 60	0	6	0	6
60 to 70	1	5	0	3
70 to 75	-	0	-	1

It does not seem that there is any connection between present age and tendency to use the stick for extra noise rather than fingers, feet, etc. Those becoming blind before age 10 appear about equall likely to use either method. When blindness occurs between 10 and 30 it seems that there is a preference for using the stick for any additional noise that is required. With blindness later than 30 it is rare to find extra sound being used.

In the table below the people who make noise of *any* kind when faced by the uncertainty of an obstacle are shown, set out as usual by age at blindness and at present, followed by figures denoting the number of people of that age group who never make use of such extra noise.

TABLE 13

USE OF SOUND CUES TO DETECT OBSTACLES

	Age at onset of blindness		Present age	
	Noise	Never	Noise	Never
Birth to 5	31	14	-	-
5 to 10	6	8	-	-
10 to 20	10	2	3	0
20 to 30	6	1	6	4
30 to 40	2	6	16	4
40 to 50	1	4	12	8
50 to 60	0	3	11	8
60 to 70	1	1	8	10
70 to 75	-	-	1	4

Two-thirds of those blind before 30 find additional noise helpful. The proportion of stick noise to other noise, as we have seen, increases throughout this age group until with the 20 to 30's all noise is virtually stick noise. Additional noise of any kind is seldom found helpful by those becoming blind later than 30. As to present age, all in the 10 to 20 group make extra noises, but the proportion of noise makers falls almost continuously with increasing age. As those people becoming blind after age 20 tend to be older *now* than those losing their sight earlier, one would expect this sort of pattern (see Question 6).

Question No. 17

Blind people are often supposed to have keener hearing and a more discriminating sense of touch than the average sighted person. Does your own experience lead you to feel that either or both of these suppositions is true in your own case?

Forty-three subjects feel that both hearing and touch are keener and better developed; 17 touch, but not hearing; 7 hearing, but not touch; and 33 neither.

But this is not to think in terms of some natural compensation, the automatic sharpening of the remaining senses with the loss of sight. As one person puts it, speaking of these remaining senses, "being blind doesn't make them any keener"; 39 people stress the fact that the greater development of these senses comes about through greater "use," "training," because one needs to rely on them so much more. "Greater concentration" is mentioned by 5 as partly responsible for the superiority, while other writers are "more observant," "more resourceful," "have learned to interpret" the smallest details provided by the senses. It is suggested that "the interpretation of sounds should be taught." Time and again the felt superiority of touch is attributed to braille reading; this is even used as a test case by one writer, "I suppose that as the average sighted person could make nothing out of braille, whereas I can, my touch must be somewhat keener." Against this is the fact that there are virtually no opportunities for making comparisons of one's touch sensitivity with that of other people. Whether or not it is connected with the more frequent opportunities for comparison, considerably fewer people would want to claim superior hearing. The point is made many times that hearing is not actually keener, but that a blind person listens to different things, to sounds which pass unnoticed by the sighted person because they have little significance for him. Thus, the blind person's hearing gives an appearance of being more sensitive.

In the following tables, those who feel that their hearing and touch, touch, hearing, or neither, are more developed than average are arranged, first according to age at onset of blindness, then by age now.

(Again, the 4 "unknowns" have had to be omitted.)

There is no discoverable tendency for present age to be linked in any way with feelings about the superiority of these senses. The proportion of those in any age group who feel that one or both of these senses is keener, more developed, remains constant at around two-thirds, from the teens to the seventies. Nor does there seem to be any tendency for a particular age group

TABLE 14

SELF-JUDGMENT OF ABOVE AVERAGE KEENNESS OF HEARING AND TOUCH: AGE AT ONSET OF BLINDNESS

Age of blindness	Both	Touch	Hearing	Neither
Birth to 5	22	6	2	15
5 to 10	6	2	1	5
10 to 20	1	5	0	6
20 to 30	2	1	0	4
30 to 40	6	1	0	1
40 to 50	2	1	1	1
50 to 60	1	1	1	0
60 to 65	0	0	1	1

TABLE 15

SELF-JUDGMENT OF ABOVE AVERAGE KEENNESS OF HEARING AND TOUCH: PRESENT AGE

Present age	Both	Touch	Hearing	Neither
10 to 20	0	2	0	1
20 to 30	4	3	0	3
30 to 40	9	3	1	7
40 to 50	8	3	2	7
50 to 60	7	4	1	7
60 to 70	7	2	2	7
70 to 75	4	0	0	1

TABLE 14

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Age of blindness	Both	Touch	Hearing	Neither
Birth to 5	22	6	2	15
5 to 10	6	2	1	5
10 to 20	1	5	0	6
20 to 30	2	1	0	4
30 to 40	6	1	0	1
40 to 50	2	1	1	1
50 to 60	1	1	1	0
60 to 65	0	0	1	1

TABLE 15

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Present age	Both	Touch	Hearing	Neither
10 to 20	0	2	0	1
20 to 30	4	3	0	3
30 to 40	9	3	1	7
40 to 50	8	3	2	7
50 to 60	7	4	1	7
60 to 70	7	2	2	7
70 to 75	4	0	0	1

to feel that one sense is more highly developed and not the other. One might perhaps have expected a falling away with increasing age. Similarly, there appears little connection between the felt keenness of one's senses and age of blindness. One noticeable feature is that of those becoming blind after 30, 83 percent feel that one or both senses is more highly developed, as against 66 percent of those blind before 10, and 50 percent of the 10 to 30's. This difference arises mainly because this 10 to 30 group is so much less likely than other age groups to feel that their hearing is at all above average.

Studies comparing blind and seeing children and young people on various auditory and tactile abilities have generally found that the blind do not possess any superior sensitivity. The performance of the blind children is often inferior to that of the seeing, although the two are comparable by the time the children reach early to mid-teens. There seems to be a marked lack of studies involving more than a very few blind adults, but those that are on record give little reason to suppose that the hearing and touch of the blind are more sensitive than those of the seeing. The fact that blind people cannot use vision to check upon what is heard or felt is sometimes adduced as support for their developing greater facility in interpreting those sensory cues upon which they must rely. Clearly there must be some truth in this, but at the same time this inability to across-check by sight must mean greatly reduced opportunities for learning. There is an important difference between the controlled laboratory situation where the stimuli to be attended to are defined, and the situation outside the laboratory where the blind person is likely to be attending to a different pattern of stimuli altogether from his seeing colleague. The sighted person can without doubt attain a level of ability beyond that of the average blind person when his hobby or occupation involves some aspect of hearing or touch. The fact that those subjects claiming keener touch outnumber those claiming keener hearing may reflect the greater use that the average sighted person probably makes of hearing as against touch.

Question No. 18

Do you ever/often go for a walk by yourself, just for the enjoyment, or is all your walking a means of getting somewhere?

Forty-three persons answer "yes" and 57 say "no," "never," "not on your life." Of the 43 who do walk 13 do so "occasionally," "only if desperate for air"; 12 do so "often," or "quite often"; 6 walk in the country; another 6 used to but do not walk for pleasure now that they live in towns. (One of the 6 who walk in the country did not go walking when he lived in town.) Of those who do not walk 17 find "no enjoyment in it"; 6 find it "needs too much concentration," "cannot relax"; 3 that there is too much noise; 3 get over this by walking "at night" when it is quieter and a fourth prefers the early morning. One unfortunate man, who used to walk a lot, now finds that continuous demolition of familiar landmarks has made him "a stranger in a strange land."

Of the 71 early blind, 31 go walking versus 11 of the 25 late blind (an exactly equal proportion). In terms of present age there is a sudden rise in the percentage of walkers from one-third to more than one-half when one passes 30; from there the numbers gradually fall until one is back to one-third at 60 and none at 70.

Whether one walks or not must also be influenced by where one lives. It would be ridiculous, of course, to pretend to say from casual knowledge of an area how difficult travel in that area is for a blind person. But for what little the impression is worth, three-quarters of the nonwalkers would appear to live in busy, crowded areas such as London and other large cities, whereas three-quarters the walkers live in smaller, quieter places with countryside not too far distant. However, individual differences beyond the scope of this survey must inevitably override all other factors. Thus, one finds that of two people living in the same town, or even in the same house, one goes walking and enjoys it and one does not.

Two subjects are of special interest here: one walks along reading, the other listening to a transistor radio! Most of us would envy such ability.

Question No. 19

How much of an effort, or how tiring, do you find getting about alone on foot?

The wording of this question was rather unfortunate, tending to make people think of physical fatigue rather than mental fatigue which was not the intention. The results are not seriously affected, however, as most people either answered as intended or covered both points.

Seventeen people find traveling alone a strain; 10 find it tiring; 12 very tiring; and 11 an effort. Ten find it no effort at all; 21 say that it "varies." Fifteen find that the amount of strain "varies" with familiarity ("worse in unfamiliar places"); 10 with the amount of noise; 2 with "what sort of a day I've had at the office"; 4 with tiredness; 4 with the weather conditions; and 2 with the amount of "clutter" there is on the pavements.

Those who find getting about a strain, an effort, or tiring, do so because: noise (traffic) - 11; towns ("nightmares") - 12; concentration - 17; "cannot relax," "can never let up" - 5; "gets worse because of increasing traffic" - 3; "the more noise, the more tiring"; "the older I get, the more nerve racking it becomes"; "all strain and no pleasure, body tense and mind concentrated."

On the other hand: it "can be a challenge"; "not so tiring that I do not prefer it to an odd escort" [3]; "can be tiring, but doesn't worry me"; "can relax in familiar, uncluttered parts," etc.

Taking the 31 people who find unaccompanied travel no effort, or no effort in reasonable conditions, we find that 19 were blind before the age of 5, 8 before the age of 20, 2 more became blind in their 20's and 2 more in their 30's, so that "effortless" travel seems to be more common among those becoming blind earlier. This also links with present age, in that the proportion of "effortless" walkers falls with increasing age. Twenty-two of this 31 are among those who do walk for pleasure, suggesting that half of those who walk for pleasure still find it something of an effort.

Question No. 20

As you will know, there have been a number of attempts to develop satisfactory "guidance devices," some of which are still making progress. Some of these devices use sound to indicate the presence of potential obstacles others make use of the sense of touch. Such devices have usually included something resembling a torch, to be carried in the hand, a power unit, either on a sling or in the pocket, and a third part fitting in or on the ear, on the forehead, or on the chest. Assuming that both types were available here and now (which is, alas! only an assumption), and both at the same very reasonable price, would you wish to have such a device yourself? If so, which, that involving hearing or that using touch? (Let us also assume that they are equally efficient.) To what extent would you insist that such a device should be completely inconspicuous?

Thirty-seven subjects prefer a device using hearing; 33 one using touch; 14 would use either; and 16 are not interested in having either device. Twenty-four people are not bothered about such a device being conspicuous; 10 prefer an inconspicuous device, but accept that this is secondary to its efficiency; 28 prefer it to be as inconspicuous as possible; and 28 insist it should be inconspicuous.

Of the subjects preferring a device using touch 7 do so because they feel a sound aid would be useless in heavy traffic noise, the time one most needs it to work; 11 do not want any interference with normal use of ears for conversations, crossing roads, in shops or bus, "for the things one likes to hear," and for echoes; 7 say if it could be used in conjunction with the stick and incorporated into the handle so that it would free one hand; and 2 feel that such a device would be less conspicuous than a hearing device (1 lady mentions using such a dev[illegible] "inside a muff in winter").

One person would want a continuous signal to show that the device was working, and a continuous sound might be rather wearing.

Also, seeing a wire leading to an earpiece, people might think the wearer was deaf not blind, and not offer help. (This apparently happens now with the transistor radio.)

Those preferring a device using hearing do so because: it is less distracting [2]; "as long as continued use does not impair present abilities"; touch is awkward in winter; touch is too affected by temperature; and this would leave the hands free.

At least 9 people mention this problem of hands. There is a feeling that one would not wish to dispense with a stick, for one's own sake and the general public's, and that with part of the guidance device in the other hand the blind person would be at a loss when it came to shopping or to handing over a fare. For people who must carry things about with them because of their occupation - a piano tuner for instance with his tools, or a student with his notes and writing gear - this would be particularly difficult. A device incorporated in the upper part of a stick would have obvious advantages from this point of view, although it would need to be very robust if one also intends to use the stick. An aid such as that worked upon by Witcher, embodied in a brief case, would go some way to solving the difficulty, since a certain amount could presumably be carried in the case.

Quite a number are very sceptical about such devices and cannot "imagine them being much help," besides the 16 who are not interested at all. It is suggested that unless the device had a *very* long range it would be of far less use than normal hearing for crossing roads. There is even a suggestion that such devices could be "misleading and dangerous," and several envisage using them "only in emergencies," "like striking matches in a cave."

It might be imagined that those preferring to continue without the assistance of such devices would be found chiefly, if not exclusively, among the early blind with their traditionally greater travel efficiency. (A tradition which receives some support from this survey; see Questions 5, 14, and 19.) This does not appear to be the case. The highest concentration of those not interested in such devices occurs with those becoming bling after 50. Turning to present age, we find that the highest percentages of "neither" occur among the younger subjects, those in their teens or twenties. Among the 60- and 70-year olds, only about one-quarter are not interested in some kind of guidance aid, so that late blindness rather than advanced age appears to be the deterrent. Those aged between 30 and 60 appear to be the most interested in such devices. It might be a little facile to suggest that below 30 one does not feel the need of such an aid, and beyond 60 one does not feel able to cope with such an innovation, but such an idea naturally comes to mind.

As regards preference for hearing or for touch, this shows a very odd feature when present ages are plotted. The two types are equally desirable for the 10 to 30's, after which there is quite a dramatic swing in favor of touch. This is largely reversed in the 40's, and slightly more in the 50's. The two are more equal in the 60's, and finish equal as they began in the 70's. More simply the 30 to 40's are the only group who definitely prefer touch devices to hearing. Several subjects with some hearing impairment, who tend to prefer touch devices, come into this age group, but even with these omitted the 71 percent favoring touch, as against 12 percent for hearing, is only reduced to 62 percent. There seems no connection between age at blindness and preference for hearing or touch. On this occasion the irregularities of the table did disappear when the figures were corrected to take account of the subjects with hearing deficiency. It may be noted that none of those becoming blind after age 50 prefer auditory devices, which fits with the findings of Questions 1 and 16.

The following tables show the percentages of subjects in a given age group - either according to age at blindness, or present age - preferring a hearing device, a touch one, either or neither. The figures from which the percentages are calculated do not include the 4 people whose age is not known, nor the 11 subjects with some hearing impediment.

TABLE 16

PREFERENCE FOR AUDITORY OR TACTILE OUTPUT OF A GUIDING AID: AGE AT ONSET OF BLINDNESS

Age at onset of blindness	Hearing	Touch	Either	Neither
	%	%	%	%
Birth to 10	42	27	17	14
10 to 20	42	33	17	8
20 to 30	20	80	0	0
30 to 40	50	12	12	25
40 to 50	66	33	0	0
50 to 60	0	33	33	33
60 to 65	0	0	0	100

TABLE 17

PREFERENCE FOR AUDITORY OR TACTILE OUTPUT OF A GUIDING AID: PRESENT AGE

Present age	Hearing	Touch	Either	Neither
	%	%	%	%
10 to 20	33	0	33	33
20 to 30	20	20	30	30
30 to 40	15	62	8	15
40 to 50	50	30	10	10
50 to 60	61	13	26	0
60 to 70	39	28	11	22
70 to 75	100	0	0	0

"Conspicuous" is unfortunately a word which does not have exactly the same meaning for everyone. So we find a very few people talking about a device which would fit into a pocket or handbag and then going on to say that they wouldn't mind if a guidance aid was conspicuous! Two people would not want the device to be noticeable, because this would "attr ct even more silly questions than one gets already." On the other hand, the view is maintained with equal stoutness that it might be a good thing if any such device were noticeable, as this would help the public to know what the blind traveler "was up to"; the idea being that if the public can see and appreciate what the blind man is doing they may be better able, and more inclined, to give any necessary assistance. A few people positively welcome the chance of explaining the gadget to curious enquirers. Thus, one man finds that "the general public, when they see a braille watch, for instance, show a friendly interest, and I suspect it would be the same with a guidance aid." A very typical feeling with a tinge of resignation is the following "I hate being conspicuous, but would risk it if it brought results" meaning, of course, "if the aid was a real help."

If one takes the two extremes, those who are not bothered about conspicuousness and those who would insist on a more or less inconspicuous device, it does look as though the older people have a stronger preference for passing unnoticed, although the numbers hardly permit this to be stated with much emphasis. Similarly, with age at blindness, one finds that of those becoming blind after 50, only one is unconcerned about the appearance of the device. Forty-two percent of both sexes come into the "prefer inconspicuous" category but, whereas 29 percent of the men do not mind the device being conspicuous, this figure is 10 percent lower for the women; the proportion of women who would insist on the device being such as not to attract undue attention is correspondingly 10 percent higher (38 percent).

CONCLUSIONS*

1) Two-thirds of the 100 blind people in the sample preferred shoes that make a noise, although almost half of these stipulate limited noise. The amount of noise preferred correlates with the age at which the person became blind; after the age of 40, quiet shoes are the rule. There is also some correlation with present age, which may or may not be a real relationship.

2) It is not possible to say that those preferring quiet shoes do so because they cannot use the "echoes" from footsteps, since some of them obviously can use such cues very effectively.

3) Ninty-eight of the 100 do carry a stick. The 16 who mainly carry their stick, as opposed to using it, tend either to have a little vision or to be youngish, early blind subjects.

4) Most people use their stick primarily for keeping contact with the wall, secondly for locating steps and curbs and for detecting and guarding against obstacles.

5) Although many more tap with the stick on occasions, only 10 regularly use it for this purpose; they appear to do so both to probe the ground ahead and for the sound. There does not seem to be any other factor readily distinguishing these people from the majority.

6) A wall is definitely the most popular to walk beside, followed by fence, railings, and hedge. Railings are the most controversal. That the wall must be of a certain height is stressed by many - all early blind. The order of preference is remarkably constant, probably because it is the same for auditory cues and for information gained through use of the stick.

7) The majority tend to walk towards the inside of the pavement, following the wall. There appears to be nothing to distinguish those who keep to the middle, follow the curb, or vary their route according to circumstances. The difference probably lies in the characteristics of the area in which they travel.

* The reader should bear in mind, throughout the above, the cautionary note on page 6 headed Important.

8) Approximately half never travel without a stick. Whether one ever goes out without a stick and how well one fares appears to be linked with age at blindness, the early blind managing rather better. Absence of the stick is associated with unpleasant feelings, particularly loss of confidence. The use of a stick appears, one might say, to be "habit forming," so that those who formerly managed without would now feel decided discomfort.

9) Snow and wind are the least popular weather for traveling because of their effect on sound and the obliterating of "landmarks" by the former. Rain is also disliked, largely because of the increased traffic noise. Ice, fog, and sun are mentioned by some, the last mainly because it dazzles the partially sighted. There is little, if any, correlation between either present age or age at blindness and the most disliked weather.

10) Open spaces are the most trying to negotiate, followed by noisy or crowded places. Railway stations, shopping centers, and downward flights of steps are particularly unpleasant. The early blind, particularly, have a dislike of excessive noise.

11) Only 15 people feel that they do not always get all the help they need in their travels. The main burden of the anecdotes of "wrong" help is that people will so often push, pull, or generally manhandle the blind person. Others who help from a distance also create problems. Such "faults," for lack of a better word, arise, it is universally agreed, through lack of understanding. Those who, to preserve their "independence," curtly reject offered help are roundly condemned by most of the sample who make a point of accepting even unecessary help for the sake of other blind people.

12) Only 11 people feel that they walk in a straight line; this is slightly more common among early blind subjects and among the younger, but is not markedly so.

13) The stick is used for one's course, to find curbs and against obstacles; the early blind tend to stress "low" obstacles below the hearing level, and to find a connection between hearing and the stick which is used to make noises. Hearing is used for "the general scene," beyond the reach of the stick, for traffic, approaching people, and obstacles. Nobody becoming blind later than age 38 mentions hearing obstacles. Some stress the role of the stick, others of hearing; the two have different but complementary parts to play.

14) Hearing, for most, is used less indoors where memory largely takes over.

15) Approximately half the sample feel that detection of obstacles at a distance is due to hearing alone or to hearing plus some other sensitivity. Only 16 accept belief in a "sixth sense," and these are mainly those aged 60 and over, irrespective of age at blindness.

16) The most mentioned obstacles are bicycles, roadworks, posts, prams, and children's toys. Three features are preeminent: obstacles which are not permanent, but which may or may not be in a given spot; things too "thin" or too low to be heard; holes, steps, etc., which might cause a fall and which are particularly difficult to detect by stick or hearing. It is suggested that there are several factors which must be taken account of when assessing the seriousness of a given obstacle.

17) Seventy-four of the 100 possess some obstacle detection ability. Virtually all the early blind have this ability, and about half the late blind. The early blind appear to be more capable in terms of sensing things at greater distances, than those blind later, and there is a slight tendency for the younger also to be better at such sensing. Performance is affected by the size of the object, its substantiality and to some extent its shape, by amount of extraneous noise, and hence by the weather and the time of day, by how one feels, and whether one is concentrating.

18) The majority have experienced an illusion of an object nearby. Again, this is rather more common among the early blind, but this may have no significance. Explanations are in terms of subjective factors, such as fatigue, "shadows," air currents, or "freaks" of acoustics.

19) Besides the 39 who tap with their stick when they want additional noise for obstacle detection, 36 find other noises helpful: clicking fingers or tongue, whistling, or coughing. The proportion of noise makers falls as present age increases, and age at blindness shows some relationships with the tendency to make additional noises and also what sort of noises.

20) Forty-three feel that both their hearing and touch are more developed than the average sighted person's; 33 do not. There is a stronger tendency to feel that touch is improved than to feel that this is true of hearing. Any improvement is brought about through necessarily greater use.

21) Less than half find enjoyment in walking alone; these represent exactly equal proportions of the early and late blind. The elderly tend not to walk for pleasure. Those who do not find no enjoyment in it because of the noise about them and the constant need for concentration. To a limited extent, the place in which one lives affects whether one walks or not.

22) Only one-tenth of the sample find unaccompanied walking

no effort at all. Another 21 find it comparatively easy given the right conditions, but for the majority it is a strain, tiring, an effort. The degree of strain again correlates with age, both at present and at blindness.

23) Eighty-four of the 100 would like a "guidance device," and are divided fairly equally between one using hearing and one using touch. Those who would not want such a device occur in all age groups, but perhaps most among the young and the very late blind. Those who would not mind the device being conspicuous make up only one-fourth of the sample; on the other hand, only one-fourth would actually insist on its not being noticeable. This feeling tends to be strongest among the women and, possibly, among the more elderly.

APPENDIX A: DEMOGRAPHIC NOTES

In Figures 1, 2, and 3, the distribution of the 100 people in this sample is compared with that of the blind population generally. The most appropriate date available for such a comparison seemed to be the figures published by the Ministry of Health (MOH) regarding the registered blind population of England and Wales at 31 December 1963 (see Tables 18 and 19). As the larger population totals almost 1000 times the sample, the MOH figures have, in every case, been divided by 1000 in an attempt to present a more meaningful comparison. This has, of course, necessitated a certain amount of inaccuracy in showing small variations. The diagrams should be treated as rough approximations; the MOH figures are also given, so that detailed comparison can be made, if desired, with the figures for the present sample, already given in The Sample, where the implications of these comparisons have been discussed.

Figure 1 shows a comparison by present age of the men in the sample and the larger population. Figure 2 is similar, for the women. Both sexes are taken together in Figure 3, where the distributions according to age at onset of blindness are shown.

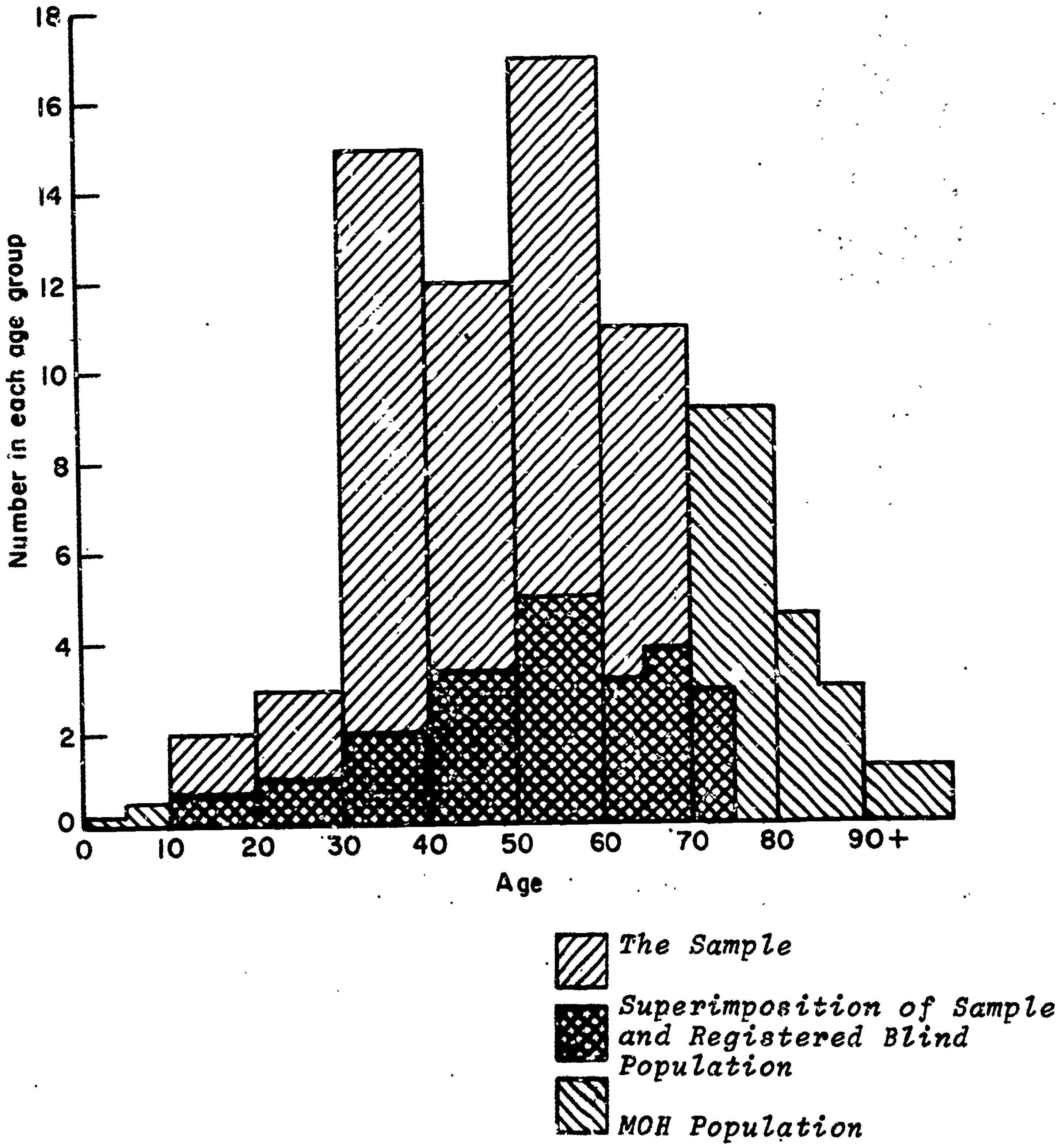

Figure 1. Distribution by Present Age for Malee in the Sample vs. Males in the Registered Male Blind Population of England and Wales.

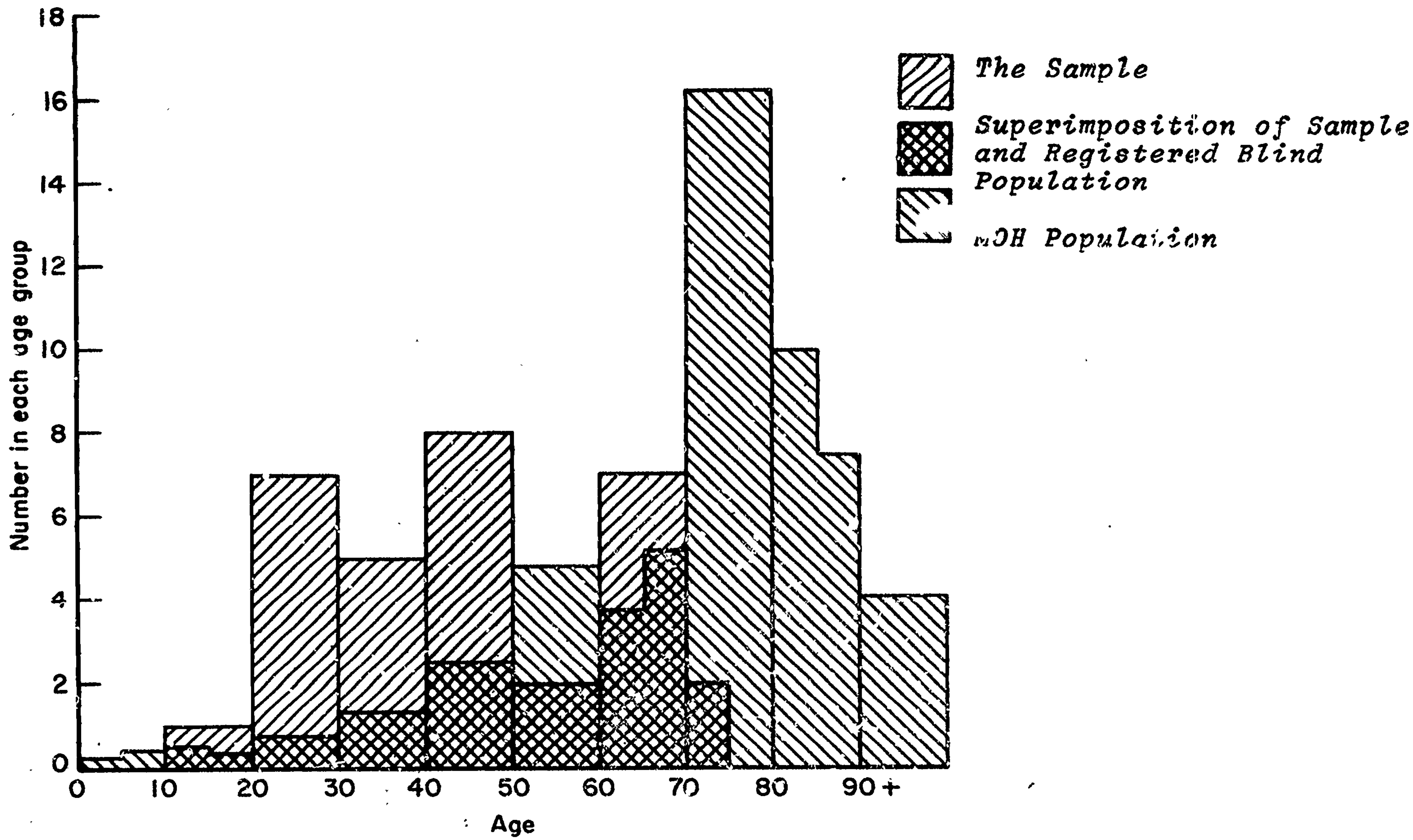

Figure 2. Distribution by Present Age for Females in the Sample vs. Females in the Registered Female Blind Population of England and Wales.

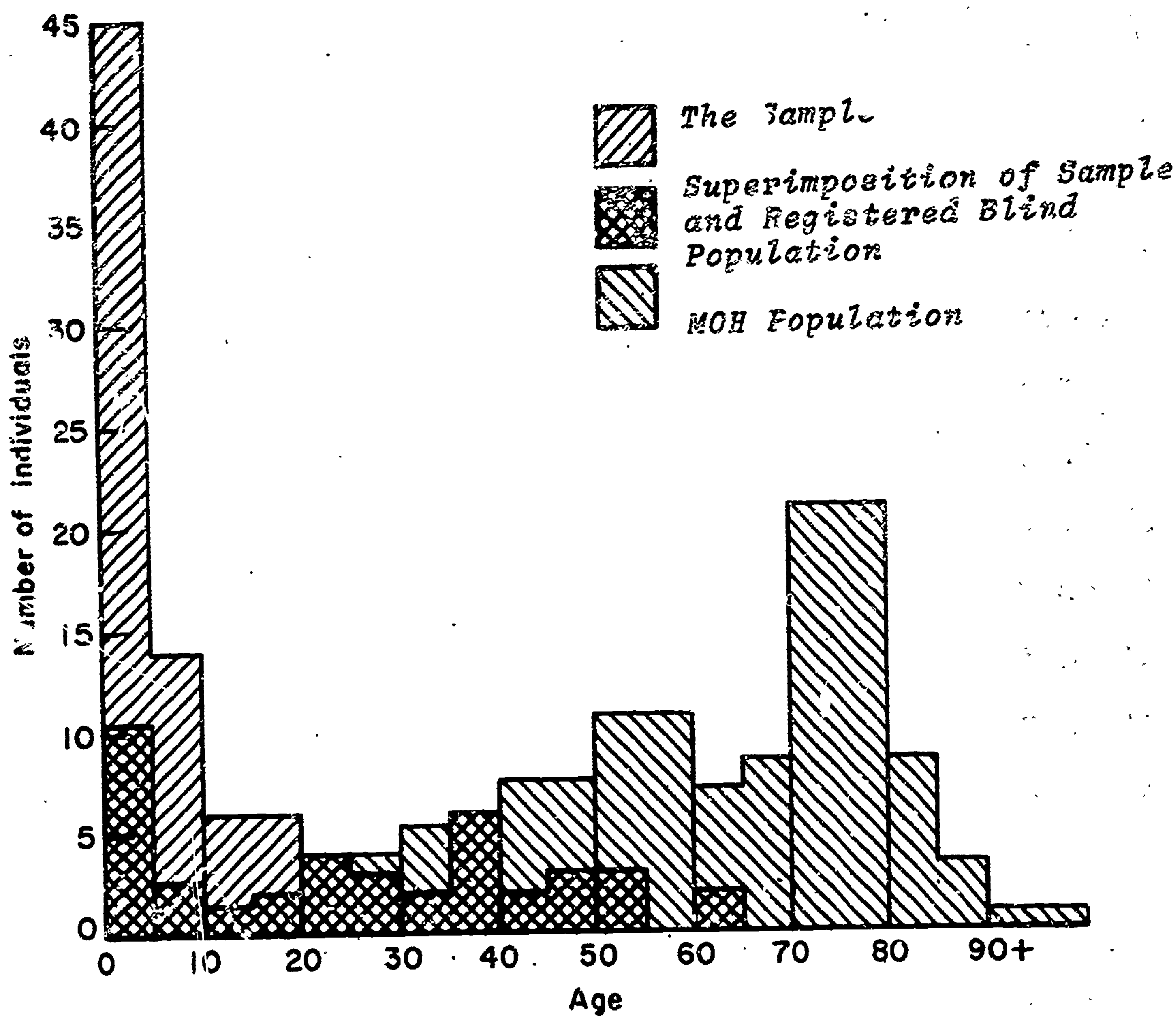

Figure 3. Distribution of Total Sample vs. Registered Blind Population of England and Wales by Age at Onset of Blindness.

TABLE 18

MOH FIGURES OF REGISTERED BLIND POPULATION OF ENGLAND AND WALES, 31 DECEMBER 1963: PRESENT AGE IN YEARS

Present age in years	Male	Female	Totals
Under 1	4	7	11
1	28	15	43
2	30	40	70
3	59	27	86
4	61	43	104
5 to 10	486	383	869
11 to 15	571	481	1,052
16 to 20	551	374	925
21 to 29	1,122	776	1,898
30 to 39	2,001	1,330	3,331
40 to 49	3,443	2,585	6,028
50 to 59	5,143	4,763	9,906
60 to 64	3,242	3,714	6,956
65 to 69	3,927	5,219	9,146
70 to 79	9,243	16,293	25,536
80 to 84	4,621	9,930	14,551
85 to 89	3,019	7,585	10,604
90 plus	1,214	4,119	5,333
Unknown	11	12	23
	38,776	57,696	96,472

TABLE 19

MOF[illegible]GURES OF REGISTERED BLIND POPULATION OF ENGLAND AND WALES, 31 DECEMBER 1963: AGE AT ONSET OF BLINDNESS IN YEARS

Age at onset of blindness in years	Male	Female	Totals
Under 1	4,560	4,206	8,766
1	261	251	512
2	211	205	416
3	175	185	360
4	178	203	381
5 to 10	1,282	1,484	2,766
11 to 15	835	798	1,633
16 to 20	1,237	992	2,229
21 to 29	2,420	1,571	3,991
30 to 39	3,087	2,440	5,527
40 to 49	3,658	4,061	7,719
50 to 59	4,281	6,409	10,690
60 to 64	2,672	4,576	7,248
65 to 69	2,893	5,532	8,425
70 to 79	6,687	14,366	21,053
80 to 84	2,496	6,066	8,562
85 to 89	965	2,607	3,572
90 plus	201	739	940
Unknown	677	1,005	1,682
	38,776	57,696	96,472

APPENDIX B:
AGE AT BLINDNESS

Apparent differences in behavior or in ability between those becoming blind in later life and those blind at birth or from childhood have been referred to frequently. It might be of some interest to gather all these apparent differences together to see what kind of picture they form.

It is the early blind who, in Question 10, stress the great importance of hearing, and while they too mention hearing traffic and other pedestrians, they lay emphasis on the hearing of echoes from obstacles. It is the early blind who, in Question 13, mention low obstacles - obstacles too low to be heard - as being a nuisance. In Question 3 it is they who point out that a wall must be of sufficient height to be detectable by the ear, and in Question 14 it is the early blind who report detecting obstacles at the greater distances. Those who "carry" rather than "use" a stick (Question 2) tend to be early blind; they are the most likely to be able to walk in a straight line (Question 9) or at least to feel that they do so; and the least likely to find unaccompanied travel a strain (Question 19). Not surprisingly, in view of this, they are the ones who manage the best if out without a stick (Question 5). It seems that the early blind are the people who find extra noise helpful, whether produced by footsteps (Question 1), by the stick, or by other means (Question 16). Conversely, it is they who most dislike noisy places (Question 7).

The picture suggested by all this is surely one of people making a great deal of use of sound reflections. It should not be forgotten that 50 percent of the late blind also report being able to detect obstacles by "echo," but they seem to be altogether less concerned with sound reflections. Not all the early blind prefer noisy shoes, tap with their stick, or click their fingers; not all find walking a comfortable business, or the detection of obstacles an easy matter. It does not follow that someone becoming blind in early life will necessarily be a particularly efficient traveler, but probably he has a better chance of achieving this than most of those becoming blind twenty or so years later.

A valid objection to some of the above is that in this survey the late blind were also, on balance, the older in terms of present age, so that it is not always possible to say whether a given difference should be attributed to their later blindness or their greater age. For this reason, however, age at present has been shown in many cases, as well as age at blindness, so that the reader may judge for himself which factor he feels is the most relevant. The fact that the two groups are fairly similar in numbers and distribution beyond the age of 50 often helps to indicate whether age now or age at blindness is the important thing.

APPENDIX C: NOTES ON DIFFICULTIES OF TRAVEL FOR THE BLIND

One impression recurs time and time again throughout this survey, and yet has not really been sufficiently emphasized in any one place. This is that the problems facing the blind traveler are steadily getting worse year by year. I am not here thinking of increased difficulties due to ageing, with the losses in sensory acuity which this may bring.

A major cause of these increased difficulties is, of course, the rising volume of road traffic. Obviously this adds to the difficulties and dangers of crossing roads, but the attendant increase in noise may constitute an even more serious problem for the blind person. More traffic also means wider roads, more islands, angling-off the corners of side roads to avoid "blind" corners, more car parks to negotiate, more traffic signs, parking meters, and steps leading to underpasses. The need for such changes naturally means more roadworks.

Whatever may be the aesthetic merits of present trends in town planning, it is certain that some of these create added difficulty for the blind person, over and above those mentioned. Such planning means very wide pavements of asphalt or other composition (which make little noise underfoot), raised "platform" pavements approached by flights of steps, more trees, posts, and other obstacles. It also means houses set back from the road behind lawns with no garden wall or fence to follow, or housing estates or flats with large open forecourts.

Many of these "difficulties" do, of course, offer advantages from another point of view. Underpasses are particularly useful if you want to cross the road, and houses set back without garden walls certainly do not present doorsteps jutting on to the pavement. But, by and large, there was a general feeling in the answers to the Questionnaire that travel is becoming ever more of a strain.

Blind travelers constitute only a very small group, relative to the general population, and their convenience and safety must often be outweighed by considerations affecting the larger mass of people. Nevertheless, many may feel that more account could be taken of the needs of blind people in matters such as, for instance, the setting of posts and parking meters, or the provision of adequate guardrails to flights of steps and temporary excavations. Certainly the knowledge that these problems are not static but are becoming more serious, particularly perhaps the question of noise, should give added incentive - if any were needed - to those engaged in research into existing mobility techniques to explore the possibilities of solving these difficulties and of devising new approaches.

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THE MUSICAL ABILITY OF BLIND CHILDREN

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INTRODUCTION

It is customary to regard blind people as being musically gifted by the very fact of blindness. Acceptance of the concept of normally distributed human abilities negates the a priori view with regard to musical gifts. The reliability and validity of tests used in some earlier studies which involved children, was not high (1,4,6). The Wing Test of Musical Intelligence (18) which has a reasonably high validity and reliability (of the order of 0.9) was used in the present study. As seen by the writer the problem seemed to be:

1) to find some way of recording the performance of a group of blind children in a test of musical intelligence which has been found, on a large sample of sighted people, to be reasonably reliable and valid;

2) to obtain some measures of the general ability of the children in the same sample;

3) by suitable statistical procedures to compare the results obtained in such a way as to display and general difference in level of performance in the two kinds of test.

The procedures in item 3 would be facilitated by the data obtainable from a control group of sighted children who should be able to give an indication of the effect on the scoring in the test of musical intelligence of a nonstandardized answer sheet. This means that the test of musical ability must be applied to a sample of sighted children of a similar general intelligence range and socioeconomic status in such a way as to approximately parallel all the obvious difficulties met with by a blind child in response recording. The results should then permit a tentative indication of the musical ability of blind children compared with that of sighted children. Comparison may also be made between the general and musical intelligence of the sample of blind children tested.

OUTLINE OF PREVIOUS RESEARCH

Very few inquiries into the musical ability of the blind have been carried out in the last 50 years. Seashore and Ling(11) attempted the comparison of the blind and sighted in music using 15 blind and 15 sighted subjects. They concluded that the blind and sighted are equally sensitive to the direction, intensity, and pitch of sound. R. V. Merry (6) reported his own experiments which involved the application of the Seashore Musical Talent Tests to 48 blind children. The means obtained were higher than for an unselected group of sighted children of the same age range. A significant number of individual scores were very low.

R. M. Drake (1) has described the results of testing all the pupils of an American school for the blind, using his own tests. The blind were found to be 'very superior' to the sighted in the "memory for melody" test only. Kwalwasser (4) tested 100 blind children using the eight Kwalwasser-Dykema tests which did not require the use of musical notation. In comparison with the sighted, their means for pitch discrimination, intensity, and tonal movement were average, but means for tonal memory, tonal quality, time, and rhythm discrimination were somewhat better than average. The Seashore measures were administered to 282 nonmusicians, 148 music students, 150 blind nonmusic students, and to 17 blind music students by Sakurabayashi, Sato, and Uehara (10). No clear difference between the performance of the blind and sighted was found, although music students returned higher means than nonmusic students. A recent American study by K. Heim (3) and cited by Wing, (19), showed that for a sample of 155 blind persons, 115 of whom were over 17 years of age, the distribution of scores on the Wing tests was approximately normal although some bias toward low scores was noted.

The studies mentioned, although by no means conclusive, would seem to suggest that in music the blind are of generally average ability by reference to norms available for the sighted.

PLAN OF INVESTIGATION

Subjects and Materials

The design of the research was as follows. A fairly representative group of blind children was chosen from two primary schools for the blind centerd in urban areas about 100 miles apart. No child was so severely handicapped that he could not benefit from education geared to normal blind children. The schools gave, in approximately equal proportions of boys and girls, a total of 90 children.

Initially a class of primary school children in the age range 10 to 11 years was chosen as a control group. On analysis the music scores were below average. A similar procedure was carried out on the age range 11 to 12 years using a class of whom 50 percent had been selected for selective secondary education. The results suggested that a more even spread of musical ability had been obtained. Eventually a primary school, which on average sends 20 to 25 percent of its pupils to grammar schools was chosen as a sample representative of the general school population of the area since it is a one-stream school, and all ability ranges are represented in each class.

The Wing Test of Musical Intelligence, suitably modified, and the Murray Test of English Attainment were taken by the blind children. Figures for the Williams Intelligence Scale for Children with Defective Vision were made available. The sighted took the Wing and Murray tests, general intelligence levels in relation to one another being assessed by end-of-year results.

Experimental Procedure

Blind Subjects

A small number of children in one of the schools was used as pilot sample for the development of a group method of application of the Wing Tests of Musical Ability. This method involved the use of Taylor Arithmetic Frames and 'Type' which lend themselves to the answering of multiple choice questions, since any convention may be adopted using the numbers 1 to 10 as required (7,8,9). The original scores of part of this sample, which consisted of about a dozen children, were included in the later totals since the whole sample was of only moderate size. Various alternative methods of recording responses were tried out to discover which was most feasible. The resulting scores were perhaps somewhat affected by practice: but this was of little importance since methods of recording the responses which involved the least difficulty for blind children were being sought.

The methods of recording the responses actually adopted together with the procedure involved in their evolution are fully described elsewhere (9, pp. 47-57, and 117-125). Once the method of response to music tests was decided, the possibility of adapting a published test of intelligence for blind children was investigated. Considerable discussion with heads and assistant staff of the schools concerned brought to light a general feeling that the time required for testing, once adaptation had been attempted, would be prohibitive. A further point made was that any results obtained would be likely to be unreliable. Eventually, it was agreed that the Murray Test of English Attainment (7) should be applied to the children in both schools for the blind and to a sample of sighted children of a similar socioeconomic and age level in order to have some indication of the relative ability levels of the age groups concerned. The sighted children were also employed in assessing the differences, if any, made by the particular mode of application of the music tests.

More than half the total sample of blind children had been tested on the Williams Intelligence Scale, and the writer is grateful to the staffs of the schools concerned for the time spent in obtaining the necessary figures for the rest of the sample (13).

Sighted Control Group

The musical education obtaining in the school is of the normal kind. Choral, simple instrumental, and appreciation work are included. The Murray Test of English Attainment was taken by all children over 8 years in the school. The same children were subdivided into two groups matched for chronological ages in order to investigate the effect of giving the Wing Tests of Musical Ability in a manner resembling as nearly as possible that in which it was given to blind children. Full details of procedures concerning control group are given elsewhere (9, pp. 65 - 75).

It is hoped in a later article to describe the form of application to blind children actually adopted in respect of the Wing Test of Musical Intelligence. This form differs from one adopted by K. Heim (3) in that normally brailled (or pencilled in the case of the partially sighted) responses need not be used, thus opening the field of testing to a lower age range.

The results obtained were tabulated to yield comparisons between the 8+, 9+, 10+, and 11+ blind and sighted children in music and English. Details of this analysis can be supplied on application to the writer, as space does not permit their inclusion here.

The Wing tests were also factorized by themselves for comparison with the scores of sighted children carried out by Wing.

In analyzing the results of the tests administered no attempt was made to differentiate between different degrees of blindness, between those adventitiously or congenitally blind, or between children with multiple handicaps. Of necessity, those unable to record answers because of a certain degree of spasticity or other handicap were excluded from consideration. Of the 90 blind children tested, 2 were unable to complete the tests: their difficulties were ascribed to spasticity.

STATEMENT OF RESULTS

The age ranges of the various groups used are shown in Table 1. The mean ages in each group do not differ significantly. The numbers of boys in each sample are about as evenly matched as one might expect in samples of this size. Thus the samples may be of similar chronological ages. The selection of the sighted sample has already been described. The proportion of blind children tested compared with the total blind population of the age range considered is fairly high. In England and Wales the total school age totally blind population between the ages of 5 and 15 years is about 1200 children. On this basis the blind sample tested must represent about 16 percent of the 8 to 12 year school population already mentioned (12).

Table 2 suggests that the blind have not attained significantly higher mean scores than the sighted in three age ranges. As in the case of other tests of a more general kind applied by Gomuliki (2), the youngest children are behind their older colleagues when compared with the attainment of sighted children of the same age. The technique used for summing the probabilities given by each age range is explained in Lindquist (5). This may be used where independently performed experiments do not individually indicate significant differences between means under investigation. T summed probabilities yield a 0.05 probability that other samples of blind children would be found superior in performance at the test concerned. Except for the 10 to 11 year age range, the sighted seem to obtain average scores closely corresponding to those published by Wing (17), which, of course, are obtained from smoothed curves.

The further analysis of music scores shown in Tables 3 and 4 seems to indicate that within each age group there existed a fairly similar pattern of differences between means. Additionally for each subtest the scores for blind and sighted children in each age range were turned into standard scores. These scores for blind and sighted were separately summed. The separate means for blind and sighted for all age ranges combined were calculated to see whether the pattern of differences indicated in Tables 3 and 4 was altered by giving more weight to the distribution of scores. The results are shown in Tables 5 and 6.

Two slightly different results were obtained for Test 3 in the 11+ group and for Test 6 with the 10+ group. The further analysis clearly confirmed the pattern indicated by Table 4.

Upon the completion of testing the totals for the first three tests were intercorrelated with the totals for the whole battery. For the sighted, Wing has reported figures in the region of 0.9. In this case, using all the blind children tested, giving a sample which had a large age spread, the Pearson r was 0.950 ± SE 0.011 (N = 88).

The music results of the sample of 76 children and those of the total sample of 88 were correlated with chronological ages. The figures are not very high since a few very young children as well as some of the older ones made high scores.

The Pearson r's found were:

r = 0.352 ± SE 0.101 (N = 76)
r = 0.316 ± SE 0.096 (N = 88).

DISCUSSION AND CONCLUSION

Quite clearly in Tests 1 and 2, where ear acuity mattered greatly, the blind excelled. Test 3 which demanded ear acuity, memory, and

TABLE 1

AGE RANGE AND NUMBERS IN THE MAIN SAMPLE USED

	Blind						Sighted					
	Boys	Girls	N	Years	Months	SE (Months)	Boys	Girls	N	Years	Months	SE (Months)
11+	16 +1*	7	23 +1	11	6.16	±.790	14	18	32	11	5.78	±.630
10+	5	13 +1*	18 +1	10	5.79	±.550	14	14	28	10	4.30	±.715
9+	9	9	18	9	4.90	±.580	18	20	33	9	5.3	±.650
8+	12	5	17	8	4.12	±1.06	17	15	32	8	4.27	±.620
TOTAL	42	36	78				63	67	130			

*Did not complete test.

TABLE 2

MEANS OF BLIND AND SIGHTED CHILDREN ON THE WING TEST

	Blind			Sighted			't' in favor of the blind (+)		F in favor of the blind (+)		Norms for sighted on Wing Test
	M	SE	SD	M	SE	SD	't'	'p'*	'F'	'p'	
11+	60.96	±3.28	16.03	56.34	±1.90	10.73	+1.27	0.26	+3.24	.01	56
10+	71.16	±4.02	17.50	47.16	±1.93	11.55	+5.00	<0.01	+1.85	.07	53
9+	56.79	±4.98	21.08	47.48	±1.64	10.07	+2.19	0.07	+3.24	.01	48
8+	45.44	±3.41	14.04	44.20	±1.17	6.49	+0.31	0.82	+3.38	.01	44

*Probabilities that the blind are superior gives $\chi^2 = 17.6$, 8 df, i.e., blind better at $p = .03$ level.

TABLE 3

MEANS OF BLIND AND SIGHTED SAMPLES ON THE INDIVIDUAL WING MUSIC TESTS

Age Range/Test			1	2	3	4	5	6	7
11+	N = 23	Blind	10.43	15.65	13.50	4.65	6.30	5.38	5.05
	N = 32	Sighted	5.25	14.20	13.70	5.75	5.69	6.00	5.75
10+	N = 18	Blind	12.20	20.60	16.20	5.16	6.55	5.55	4.90
	N = 28	Sighted	3.86	13.10	9.96	4.83	4.80	5.56	5.05
9+	N = 18	Blind	9.62	16.20	10.90	5.75*	5.66	5.00	3.66
	N = 38	Sighted	5.60	12.40	11.58	5.85	4.11	5.10	4.84
8+	N = 17	Blind	8.35	11.35	9.74*	4.18	4.00	4.35	3.47
	N = 32	Sighted	4.10	11.61	8.90	4.76	4.84	5.00	4.99

*Indicates means adjusted as indicated by the control experiments.

TABLE 4

DIFFERENCES BETWEEN MEANS FOR BLIND AND SIGHTED FOR THE INDIVIDUAL WING MUSIC TESTS

Age Range/Test	1	2	3	4	5	6	7
11+	5.18_B***	1.45_B	0.20_S	1.10_S	0.61_B	0.62_S	0.70_S
10+	8.40_B***	7.50_B***	6.24_B**	0.33_B	1.75_B**	0.01_S	0.15_S
9+	4.02_B***	3.80_B*	0.68_S	0.10_S	1.55_B**	0.10_S	1.18_S
8+	4.25_B**	0.26_S	0.84_B	0.57_S	0.84_S	0.65_S	1.52_S

Note: Differences which are in favor of blind and sighted are indicated by the suffixes B and S respectively.

Differences marked *** are significant at $p = 0.001$ level
Those marked ** are significant at $p = 0.01$ level
And those marked * are significant at $p = 0.05$ level.

TABLE 5

MEANS AND SD'S FOR INDIVIDUAL SUBTESTS OF THE WING BATTERY

Age Range/Test		1	2	3	4	5	6	7
11+	Mean	7.42	14.70	13.60	5.10	5.95	5.73	5.45
	SD	4.61	5.45	4.64	2.17	2.74	1.97	1.91
10+	Mean	7.13	16.10	12.40	5.00	5.47	5.65	4.98
	SD	5.16	6.20	6.25	2.12	2.56	2.24	1.97
9+	Mean	6.91	13.70	11.38	5.80*	4.60	5.07	4.35
	SD	4.15	5.61	5.21	2.11	2.72	2.67	1.94
8+	Mean	5.57	11.50	9.10*	4.55	4.78	4.78	4.46
	SD	3.63	3.60	2.79	2.77	2.13	2.47	1.91

Note: Scores for both blind and sighted are included for each age range.

*Scores adjusted as indicated by control experiments.

TABLE 6

SEPARATELY SUMMED STANDARDS SCORES 'Z' FOR BLIND AND SIGHTED USING POOLED RAW SCORES

Age Range/Test		1	2	3	4	5	6	7
11+	Blind	+13.52	+4.07	+0.37	-4.84	+4.12	-1.83	-3.40
	Sighted	-13.52	-4.07	-0.37	+4.84	-4.12	+1.83	+3.40
10+	Blind	+16.02	+13.60	+10.69	+5.32	+3.90	+0.56	-0.86
	Sighted	-16.02	-13.60	-10.69	-5.32	-3.90	-0.56	+0.86
9+	Blind	+11.74	+8.02	-1.58	-1.16	+4.72	+1.82	-6.92
	Sighted	-11.74	-8.02	+1.58	+1.16	-4.72	-1.82	+6.92
8+	Blind	+11.48	-2.28	+4.01	-4.35	-3.64	-2.92	-8.70
	Sighted	-11.48	+2.28	-4.01	+4.35	+3.64	+2.92	+8.70
Mean of 'Z' all age ranges	Blind	+0.694	+0.301	+0.177	-0.099	+0.120	-0.079	-0.254
	Sighted	-0.406	-0.177	-0.104	+0.058	-0.092	+0.046	+0.149
Differences between mean 'Z' scores		1.100*	0.478*	0.28*	0.157	0.212*	0.125	0.403

*Differences in favour of the blind.

the ability to count, gave the blind some advantage; this, however, possibly was vitiated by a less well-developed sense of number than in the case of the sighted. Test 5 was the only other in which the blind were generally superior. The test was one of judgment as opposed to perception, but, except for the youngest age group, the subjects were able to register preferences for harmonies of a more sophisticated kind than were their sighted colleagues.

The test of English used was stated by its compiler to be unreliable below the age of 10 years. However, a generally steady gradation in mean scores is observable in Table 7. With one exception, the difference between means for the corresponding blind and sighted groups are highly significant. The probabilities obtained in this connection, when summed, suggest that at the 0.01 level of confidence other samples of blind and sighted children would show similar differences. The blind sample, judged by the results given by Murray (7), appear to be of generally average ability in English, except for the 10 to 11 age range.

The evidence afforded by the mean scores in English permits the tentative inference that the sighted children were generally more intelligent than the blind. There are no available figures which would permit a direct comparison on the basis of intelligence.

Using the individual scores, it would seem that an English Quotient to for the blind based on the norms provided by the sighted is of the order of 80 to 90.

Differences in means for music and English found to be statistically significant between the blind and sighted possibly reflect the conditioning of the children concerned; in particular the dependency of the blind on the development of aural and verbal awareness. This in turn could lead to heightened aural activity by sheer use and constant readjustment of that ability, together with a tendency to 'verbalize' which means that a fairly wide vocabulary is developed without a corresponding awareness of all the meanings involved.

An interesting feature of Table 2 is the significance of the differences in standard deviations in the various age ranges. As the ages decrease, the ratios of the variances involved increase as follows:

Age	Ratio of variances Blind/Sighted
11 +	2.38
10 +	3.13
9 +	4.40
8 +	4.70

TABLE 7

MEANS OF BLIND AND SIGHTED SAMPLES ON THE MURRAY ENGLISH ATTAINMENT TEST COMPARED WITH THE NORMS GIVEN BY MURRAY FOR BLIND CHILDREN

	Blind		Sighted						Norm for blind child population	
	M	SE	M	SE	't'*	P	F	P	M	SD
11+	26.00	±1.79	35.13	±1.63	+[illegible].56	<0.010	+.265	0.60	26.67	10.72
10+	31.11	±2.40	27.48	±1.75	-1.185	0.240	-.683	0.50	20.50	8.79
9+	19.16	±1.83	23.77	±1.09	+2.29	0.025	-.710	0.25	16.55	7.11
8+	13.06	±0.91	17.10	±0.77	+3.18	<0.010	±.648	0.30	Not given Murray	

*Probabilities in favor of sighted gives χ^2 = 28.5 for 8 *df*, i.e., sighted better at p = 0.01 level.

It would be reasonable to attribute this to the difficulties of response recording for the blind children except for the fact that a similar situation was not observed when English ability was tested using a similar method of recording responses. It would therefore seem reasonably safe to conclude that there is indeed a greater spread of musical ability, as measured by the Wing Test, in any sample of young blind children as compared with an otherwise similar sample of young sighted children. Thus the lower marks obtained by the blind groups are just as low as one might expect from their English scores.

Musical ability seems to grow at roughly the same pace as general ability as is the case with the sighted. The absolute level of performance of the sighted at the music tests administered is lower than that of the blind possibly because of the inhibition, by reason of vision, of the development of a similar degree of aural acuity achieved by the blind. Aural acuity in the blind, however, seems to give rise to a greater spread of ability than in the case of the sighted. This may be attributed to the specialized environment normally provided for the blind: any musical ability possessed by a blind person is likely to be as fully developed as possible.

On the evidence afforded by figures for the intercorrelation of the first three with all seven subtests of the Wing Battery, it seems clear that the first three tests only can be used with a moderate degree of confidence in selecting and classifying children. This would of course shorten the testing period significantly from a total of two hours to one hour (assuming that Taylor Frames are set up ready for use), a factor likely to influence the adoption of such a testing procedure on a larger scale.

Further work might be attempted on the speed factor, since the prognostic value of the test for musical abilities may bear a positive and high correlation with the manipulative and general abilities brought into play while answering at speed using the Taylor Frames as a medium for recording answers.

The intercorrelation of music scores with chronological age suggest there is a small but positive and significant correlation with age for this sample. The results agree with those of Wing (16) and Williams (14, 15) in that they indicate a steady growth of musical abilities with age.

Conclusions Suggested by Present Study

The measurement of musical ability of blind children may be carried out by a group method down to 8 years of age (or 7 in exceptional cases) by the use of mathematical or specially constructed apparatus where multiple choice questions are given. The number of children who can be tested at any one time is of the order of 15 if one tester is available (less if a wide age range is represented in those being tested) and perhaps 50 children if supervisory staff are available in the ratio of 1 to 5 children.

An unstandardized method of presentation of the Wing Test of Musical Intelligance (such as was used in this work) did not seem significantly to affect the scores of sighted groups on the individual subtests until the age of 9 years and below.

The scores for the blind group tested were higher than those of the sighted group with an overall probability of 0.05. However, the subtests which mainly accounted for their superiority were Tests 1 (estimation of the number of notes in a chord) and 2 (detecting the direction of change of one note on the second playing of a chord). Some advantage was gained by the blind also on Tests 3 (memory for melody) and 5 (expressing a preference for a certain harmony on the second playing of a tune). In Test 3, however, it is likely that the blind had a less well-developed sense of number than the sighted: thus possibly accurate perceptions were not accurately reported in terms of the correct note number. The sighted were generally superior in Test 7 (expressing a preference for a certain phrasing when a tune is played twice) and to a lesser extent in Tests 4 and 6 which are tests of preference. The 'monotone speech' of a proportion of blind children may have some connection with this result.

The spreads of the scores for the blind in music were significantly greater than for the sighted ($p = 0.01$). This could account for the higher means recorded if it is accepted than any musical potential possessed by a blind child is more likely to be developed than in the case of an equally gifted sighted child. There was no significant similar difference in the spreads of scores for the English test. It seems that in the blind children musical ability may generally be a little better developed, because of their dependence on aural communication, than abilities in other directions such as English.

It would seem that fundamentally the blind are no better at music than the sighted; their scores in music go just as low as could be expected from their English scores. Where there is any talent, however, the concentration on aural communication sends up the norms so that the eventual means come out higher and the spread of their scores is greater than corresponding results for an otherwise similar group of sighted children.

SUMMARY

The musical ability of a sample of 90 blind children was assessed by the Wing Test of Musical Intelligence. For this purpose, a method of group application was devised by a modification of the method developed by Murray (7). The effects of an unstandardized

method of application of the Wing test and a comparison of the attainment in English of the blind group with that shown by the sighted sample were studied by the use of a control sample of 130 sighted children of approximately similar age and ability and socioeconomic positions. The control sample took the Wing and Murray tests in a way which as nearly as possible paralleled the methods used for application to the blind. In English attainment the sighted group excelled significantly ($p < 0.01$); in music, however, the blind group were superior ($p = 0.05$), this superiority appearing in only two tests of the Wing Battery where perception was of particular importance.

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THE EVALUATION OF VERBAL PERFORMANCE IN MULTIPLY-HANDICAPPED BLIND CHILDREN

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Since 1957 the Syracuse University Center for the Development of Blind Children has provided a comprehensive diagnostic and evaluation service for multiply-handicapped blind children. The majority of children seen during this period have demonstrated two or more of the following problems: visual disability, auditory impairment, neuromotor dysfunction, the brain injury syndrome, mental retardation, psychopathology, and/or cultural disadvantagedness. All children have demonstrated some degree of verbal disability. Most children have been essentially nonverbal.

It is because of the complex behavior patterns fo such multiple disabilities that a multidisciplinary evaluation team consisting of specialists in pediatrics, neurology, ophthalmology, psychology, speech pathology, audiology, social work, and special education examines each child. The children are observed and tested over a three- to five-day period, during which time they are in residence near the clinical facilities of Syracuse University and the State University of New York Medical College. The child is accompanied to the evaluations by his parents and a case worker.

It is within this setting that the following observations of the multiply-handicapped blind children were made.

Because of the relatively limited published material describing the communication skills of such children, and because of the diversity of behavior patterns and levels of communication skill within this group, it seemed untenable at the outset of the program to attempt to develop and utilize a formal clinical test battery or rigid experimental design. Instead it was hoped that the examination of a large number of children over an extended time period might lead to a framework of generalizations within which more specific experimentation and regularized clinical procedures could be developed.

With each successive evaluation the following points of view have been more fully developed. They are exposed here not as answers to questions, but rather to stimulate and assist other clinicians similarly engaged.

First, it is essential that a multidisciplinary team approach be employed. Children examined by this team have often been found to be far below measurable intellectual or social performance levels. Projection about the future development of speech and language by reference to the child's social or intellectual age alone has, therefore, been impossible. Consequently, reference to physiological age within the perspective of chronological age has frequently been an important aspect of the prognosis for the development of verbal behavior. First-hand medical information in necessary for such a procedure. It is of further importance when considered in light of the amount of time which may be spent on each of the possible prognostic areas, their ultimate value to the examiners and the child in terms of the life expectancy for the child, and the possible remission of encumbering symptoms through medical procedures.

A further example of the necessity for the team approach is seen in the important role of the social case worker who has visited the school, home, and/or institution in which the child spends most of his time. It has frequently been discovered that the meaningfulness of the parent interview is substantially altered by the report of the case worker; he can describe more objectively many of the details of the child's behavioral day, of his social development, which have both become highly subjective and rote-like in the responses of the overinterviewed parents of severely handicapped children.

Similarly, the verbal age of the child lacks full meaning unless seen in perspective not only of the physiological age determined by the physician, but also the intellectual and educational age determined by the psychologist and educational examiner. It is the lack of fit among these three developmental levels which arouses the most provocative questions and initiates the most penetrating diagnostic probing by the team members.

Second, the most complete and thorough description of the verbal behavior of the child is obtained through the use of three examiners at once (all are speech pathologists). One examiner guides and controls the child himself. He must soothe, manipulate, and reward the child as he participates in the examination. A second examiner is necessary to manipulate the material and stimuli which are presented to the child. Since most of the procedures are administered at a very low level of conditioned interaction, it is essential that the test administrator be free to control the crucial timing of the stimuli. The third examiner functions as a recorder, noting not only the stimuli given and the responses observed, but also the other behavior of the child and the comments of other participating examiners.

The freedom to perform each role more effectively allows for corroboration of responses to stimuli and observations of behavior pattern which are frequently brief in duration and extent. A further benefit is the ability of examiners to shift roles as they take turns at manipulating the child. It is impossible for examiners to know prior to seeing the child whether he will work best in a restrictive and demanding situation, in a free play or nondirective situation, or in a comforting but minimally structured formal situation. Although one therapist can, in some examinations, change roles so as to produce the best interaction pattern with the child, it appears that because of the breadth of the sensory handicap in this group of children they are not so alert to minimal changes in facial expression and vocal quality ordinarily indicating a role change, and cannot therefore respond to such changes as easily when a role is associated with a completely discrete examiner.

Third, at least three distinctly different testing rooms are important to a successful examination of verbal skills. It appears that the greater the handicap (up to the point of immobility) the greater the number of examination settings required for a thorough evaluation. In most cases three rooms, each with its own peculiar characteristics and observational facilities (including one-way mirrors and two-way amplification systems), have been employed. The child is seen first in a large play room in the presence of not only the unfamiliar examiners, but also the parents and case workers with whom the child is usually more at ease. Frequently the professional staff observes through the one-way mirror system while the parents are encouraged to let the child "show off." This examining room is large, relatively indestructible, and offers the child a variety of opportunities to demonstrate skills in step climbing, block activities, doll play, table games, balancing rocking, sliding, and in general, to perform as he might in an unstructured social free play situation.

Children seen in this first examining room are observed for gross speech, language, and hearing characteristics and are classified into one of two gross categories: a) those who show a pattern of apathy, immobility, unresponsiveness, and inhibition; b) those who are aggressive, highly mobile, distractible, and short of attention span.

Children who fit the characteristics of the first group (the apathetic) are taken for further examination into a large, sound treated, free-field audiometric assessment chamber. This room is free of outside distractions, and is heavily carpeted so that movements of the examiner are minimally notable; it contains four speaker systems each located in a different corner of the room, a two-way sound system, and an observation window. The child is placed in the center of this room, seated on the floor, and reassured by the examining therapist. The therapist remains near the child, but has no contact or interaction with him at the outset of the procedure. A second examiner, operating the free-field audiometer from an adjacent room, presents stimuli randomly through speakers located in the four corners of the room. The first stimuli presented are comfortably loud auditory cues such as the clicking of keys, a dog barking, a car engine starting, and a door closing. These sound stimuli are brief and preceded and followed by long periods of silence. If the child appears to respond to these auditory cues, the level of the stimuli and the type of responses are noted to assist in the determination of an auditory threshold. Then sound stimuli are gradually reduced in intensity until the observed behavioral changes no longer occur.

Whether or not some auditory sensitivity seems to exist, the child is left unstimulated for as long a period of time as is necessary to allow his natural curiosity or boredom to cause him to initiate activities himself.

The child's activity pattern is then verbalized over the intercommunication system so that his every act is gently encouraged and described for him. A comfortably loud voice level is determined by the previous assessment procedure. The descriptive verbalization of the child's behavioral patterns is continued for 15 to 30 minutes. After this period the examiner gradually inserts simple instructions and commands designed to have the child perform some task which he has already demonstrated his ability to enact. At this point the examiner in the room begins to interact with the child nonverbally. He may place selected objects in the child's path so that he will discover them. He may present the child with a toy or object to manipulate. He may engage in simultaneous crawling or other activities with the child. If the child responds to the presence of the examiner and makes a decision to initiate some contact, the examiner is free to engage in gross motor activity with the child. All verbal contact, however, is maintained through the intercommunication system and descriptive talk continues to accompany the simultaneous play of the second examiner and the child.

When contact has been made between the second examiner and the child, both are expected to perform the verbal instructions; this lends encouragement to the child in his attempt to follow the instructions. Following 15 to 30 minutes of such "conditioning," verbal interaction is permitted between the second examiner and the child. This verbal interaction is first a response to instructions delivered through the amplification system. Later the contact extends to become communication between the child and the second examiner.

This has been the most dramatic and most frequently successful technique employed to stimulate social interaction and establish estimated auditory sensitivity in children who have not otherwise responded to social interactions and auditory assessment procedures.

Children fitting the second diagnostic category of behavior characteristics centering around hyperactivity and short attention span are taken from the first examining room into a third available facility - a small reverberant room free of all distracting objects except one table and two small chairs. This room is also connected to an observation room via a one-way-vision mirror and a two-way sound system. The essential technique employed is to fatigue the child's hyperirritable behavior. In this case the child is usually left alone in the room. One therapist is stationed outside the door for reasons of safety (and for later interaction purposes). The other examiner observes and interacts verbally with the child over the two-way communication system. The first session of the examination must be held when no time limit will be imposed, since at the outset of the examination it is not known whether the child is unable to respond or whether he is testing limits. If the child is able to respond, it is not known whether he will respond to auditory stimuli, or to visual or tactile stimuli. Consequently each must be tested. Further, it is of critical importance that if the child is able to respond to any external stimulus and is in fact testing limits, then the examination procedure should continue until the child demonstrates some responsiveness to external control.

In this setting, hyperactive children go through a brief exploratory period and enter rather quickly into a ritualized behavior pattern which continues over a substantial amount of time. Some children demonstrate vocal behavior, frequently crying and yelling. Some remove their clothing. Some use words and approximations of verbal behavior. Others resort to destructive attacks on the room and its equipment. Frequently, children demonstrate patterns of self-injury or apparent self-injury such as biting themselves, pommelling themselves with their fists, or banging their bodies against the wall or furniture of the room. This self-inflicted injury has been discovered to be an adjustment device which plays itself out and has seldom, if ever, resulted in even minimal harm to the child. Most generally, the children eventually move into a pattern of ritualized locomotive behavior with some apparent fixation, for example, hitting a certain spot on the wall as they walk around the room, a regular attempt to open the door, or constant turning on and off of the light switch.

Whatever behavior pattern emerges, the child customarily performs the same activity over and over for a long period of time. One child, for example, walked in a circle around the small room for 45 minutes. Eventually, however, children who follow this ritualized activity pattern are observed to seek ways of breaking the pattern. If auditory sensitivity is present, an appropriately loud signal in the form of comforting sound and simple command is presented to the child. A brief pause in activity will be noted and the child will attempt to localize the sound coming from the ceiling of the room. If no auditory sensitivity is present, the second examiner may reach inside the door and turn off the light which may cause the child to change his behavior pattern, at least if minimal visibility is available to him. In the case where no auditory or visual sensitivity is present, the entry of the examiner into the the room with a distracting toy or familiar article (such as a preferred food) frequently appears to offer relief from the ritualized behavior. Through this procedure the child in effect "runs down," as if his energy resources can no longer keep pace with his need to perform ritually or to test limits.

In those cases in which the initial alteration of the behavior, and the first reward, takes place after a long time interval - perhaps two hours - the session is ended immediately after the first reward, and the child is released to other examiners until the next day, at which time the same procedure is duplicated. With this method, and over a period of time, the presentation of the reward for the end of an activity pattern which is basically undesirable to the child is associated with his interaction with one of the examiners, and through this avenue contact is established. Of all the techniques employed with the severely handicapped hyperactive child showing no evidence of previous social interaction this one has been most effective.

The reader will recognize from the above test procedures that the population examined to this date must have been functioning considerably below the levels of performance encountered in more conventional communication disorders, and that examination procedures have been evolved which are, by the same token, unconventional. For this reason, the following outline of rather specific questions is provided, to demonstrate some of the cues which suggest behavior patterns and modality capacities which have been of value to the team.

I. *Receptive System*

A. *Tactile*

1. *Does the child respond to passive holding and handling?*
2. *Can he be guided by simple touch command through gross motor patterns (e.g., walking)?*
3. *Can his attention be held at table activities (small muscle activities) through tactile stimulation?*
4. *Can he discriminate between people by touch?*
5. *After holding several objects, will he show preference for one or the other?*
6. *Does he show awareness to unfamiliar tactile stimulation (e.g., glue on the fingers)?*
7. *Does he respond differently to tactile stimulation when it is accompanied by voice or noise, in the light as in opposed to a dark room?*

8. Does he respond to differences in temperature?
9. Can he be conditioned to tactile rewards?

B. Auditory

1. Does the child smile, withdraw, or cease activity when voice is presented to him?
2. Does he show gross differential behavior to sharp command, as opposed to soothing pleasantries?
3. Can he be awakened by sounds?
4. Does he respond to nonvocalized sounds?
5. Does he follow simple verbal commands?
6. Does he listen (i.e., actively attend to sound)?
7. Does he respond differently to sound in a dark room as opposed to a light room, when being held as opposed to being alone?
8. Does he cover his ears when in the presence of noise or speech?
9. Does he react to amplification of sounds which he himself has made?
10. Can he be conditioned to audible rewards?

C. Visual

1. Is his behavior different in the dark as opposed to a lighted room?
2. In the above situations, does his behavior differ when an adult is present, when the adult talks to him, holds him?
3. Does he hold objects up to his eyes when examining them?
4. Does he respond to flickering lights?
5. Can he be conditioned to visual rewards?

II. Expressive System

A. Gross Motor

1. Does he attempt to free himself from restraint?
2. Does he "force" things when he knows they should move but when they are held firm against his efforts to move them?
3. Will he try to free himself from unfamiliar stimuli (e.g., tape on his arm)?
4. Does he direct people by holding or touching them?
5. Is he curious about unfamiliar tactile stimuli (e.g., sandpaper)?
6. Does he bite, kick, or abuse himself or others as a means of social control or contact?

B. Primitive Vocal

1. Is there a preponderance of oral to nasal tone as in normal speakers?
2. What are the acoustic characteristics of his cry?
3. Will he produce sounds in order to get a reward?
4. Does he vocalize randomly when frustrated?
5. What percentage of the time does he vocalize under different daily test conditions?
6. Is his sound pattern predominantly vowel-like or consonant-like?
7. Is his sound pattern timed with pauses as in speech or biological necessity?
8. Will he modify produced sounds in order to continue to receive a reward?
9. Does he have repetitive vocal patterns in reaction to frustration, to pleasure?
10. Does he make ritualistic nonspeech sound patterns during activity, at rest?

C. Verbal

1. If the child is at this level, a customary verbal analysis or speech evaluation protocol can be followed.

III. Central System

1. Has the child learned anything? Can he feed himself; is he toilet trained?
2. Can he remember where objects are kept or placed once he has been shown?
3. Does he show pleasure?
4. Does he seem to converse with himself?
5. When he has been put through a simple series of tasks, does he know when one step is left out?
6. When his usual means of manipulating his environment are cut off, does he adopt other means?
7. Does he react to incongruities (e.g., a chair on top of a table)?
8. Is he aware of danger?

IV. Interaction System

1. Can he imitate tactile, auditory, or visual acts or patterns presented to him?
2. Can he be instructed vocally to perform nonverbal tasks?
3. Can he be instructed by tactile demonstration

to perform vocal tasks?

4. Can he be conditioned to make different vocal responses to different tactile cues, to different auditory cues?
5. In your estimation, is the time period between a stimulus and a response sufficiently great or otherwise indicated to be available to the child centrally for consideration or is the process conducted with the speed and other apparent indications of signal behavior?
6. Is the child's interaction system primarily self-contained, that is does he prefer to handle, touch, caress, bite, and manipulate himself rather than to manipulate others or be manipulated by them?
7. Does he respond to passive motor-tactile manipulation patterns?

V. Referential System

A. Environmental Opportunity

1. Is he in a constant or varied environment?
2. How much time is spent regularly in an effort to teach or train him?
3. Whom does he come in contact with regularly and how does he interact?

B. Motivational

1. Does he explore people and show interest in them?
2. Does he explore rooms?
3. Does he perseverate in his exploratory acts?
4. Is his exploration stopped by himself or others?
5. Is he interested in discoveries made during exploration?
6. What does he do when deprived of all stimulation?

C. Personal

1. Is he generally apathetic, withdrawn, asocial, unstimulatable? Can the pattern be controlled?
2. Is he generally hyperactive, destructive, short of attention span? Can the pattern be controlled?

D. Sensory

1. A summary of through what sensory avenues and to what degree in each the child may be stimulated.

E. Expressive

1. A summary of what expressive motor abilities are

available to him for the modification and control of his environment.

A fourth point is that the child must be seen on more than one occasion - even if the separation between sessions is no more than early and late in the same day. The travel time to and from the clinic, the unfamiliar setting, and the large number of unknown examiners undoubtedly cause differences in the child's usual behavioral patterns. As the child progresses through the routine of interviews and examinations his behavior begins to change. Although the general prognosis determined in the first evaluation session is seldom reserved or markedly altered by the second evaluation, frequently substantial new information is obtained which refines previous observations. Of course, the initial tentative conclusions drawn by the examiners must be verified in the second or subsequent examination attempts. This is particularly important if a radical departure from the previously known information about the child is to be postulated.

It is crucial to the ultimate effectiveness of the team's recommendations that some observers (particularly those who have accompanied the child from his home community) be instructed in the behavior patterns they will observe and see the types of response upon which the new diagnosis is based. For example, one recent evaluation of a nine-year-old right hemiplegic child who was referred as deaf and blind revealed, in the first examining session, that he could respond to auditory commands to sit, crawl, jump, and sing. When the possibility of the child's being able to receive auditory stimulation at this comfortable level was discussed cautiously with an accompanying institutional supervisor, it seemed to be of only limited interest, and caused little change in attitude toward the child. The mother, in fact, reported that "sometimes he does seem to hear a door slam, but I think that is mostly vibration." This seeming lack of impact of what should have been a hopeful finding caused the examiners to become suspicous and doubtful of their own findings. The institutional supervisor was invited to observe subsequent testing on a second day. At this time the child performed similarly to auditory cues not much louder than a whisper (in the 20- to 30-decibel range). Upon observing the testing procedure, and seeing the results first hand, the institutional supervisor readily verified the ability to hear reported by the examiners following the first test session.

A fifth general recommendation is to examine the child prior to exploring his previous case records and prior to interviewing the parents. This recommendation is offered not to suggest specific procedures for the examination process, but as a precaution to prevent the habitual use of established examination procedures which may not be appropriate to the group being considered. Although it is customarily appropriate to review cases prior to seeing most verbally handicapped children in a clinical situation, this has not been found true in the case of multiply-handicapped blind children. Most of the children coming for an evaluation have a lengthy and detailed life history available to the examiners upon their arrival. In most cases, it has been found that the examiner can perform with greater freedom and with less prejudice if he has only three pieces of information:

1) Are there any crucial health problems such as epilepsy or heart disease which must be considered by the examiner handling the child?

2) Are there any particularly frustrating stimuli which might cause the child to withdraw excessively or rage excessively so as to delay and protract the examination?

3) Other than the fact that the child is severely and multiply handicapped, what problem precipitated the request for this comprehensive evaluation?

Another customary procedure which the examiner must modify if he is to deal successfully with the severely handicapped nonverbal blind child is the natural and frequently correct tendency to probe liabilities while ignoring capabilities and assets. For example, in the examination of an otherwise normally hearing handicapped child, it would not customarily be inappropriate to spend little time on his good visual skills, good motor skills, etc. Usually the procedure would be to explore in depth his ability to discriminate among sounds which is presumed to be poor, his ability to recognize auditory configurations which is presumed to be poor, his ability to receive and identify minimally audible sounds which is presumed to be poor, etc. In the case of the multiply-handicapped child, the general level of function and capability demonstrated is frequently so low that efforts to probe in depth these problem areas leads to frustration and subsequent uninterest on the child's part so that motivating and stimulating him becomes extremely difficult, if not impossible. Instead, the examining situation should be looked on as described above - basically as if the examination procedure were an initial therapeutic attempt. In this case the reward of appropriate behavior of any kind is customary and, in particular, a reward is given to any modification of behavior to develop the capacity to change and to build upon motivations to encourage change. In short, the number of adjustment devices available to the severely handicapped child are quite limited. When these devices have been utilized repeatedly and unsuccessfully by the child in the examination situation, he will often be observed to manifest intense internal turmoil and uncontrollable overt behavior. In these children, as indeed in all human beings, the urge to homeostatic behavior is strong, but the severely handicapped child has an additional problem of biological limitations which set very narrow bounds around the mechanisms for maintenance of physical and psychological homeostasis.

THE EVALUATION AND SIMULATION OF MOBILITY AIDS FOR THE BLIND*

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INTRODUCTION

Earlier work on blind mobility research in the Mechanical Engineering Department at Massachusetts Institute of Technology (MIT), under the Vocational Rehabilitation Administration, Department of Health, Education, and Welfare sponsorship, has focused on the information transmission characteristics of the long cane and the study of obstacle course negotiation by blind travelers (6). This experience and our cognizance of the work of other investigators concerned with blind mobility devices, such as the Haverford/Bionic infrared probe (2) and the Kay/Ultra (3) and Russel ultrasound probes (4) convince us that the most crucial, least understood and, therefore, most challenging aspect of the overall blind-mobility-assist problem is that of the display and assimilation by the user of the information acquired by the instrument.

SEARCH AND DETECTION

Progress to date by other investigators has already adequately demonstrated that the technical aspects of search and obstacle detection can be accomplished through use of optical or sonar techniques. While refinements beyond present capabilities are essential, the means by which to realize such improvements can be mustered when the utility of the devices to the blind can be demonstrated.

Similarly, problems of bulk, weight, complexity, and reliability of the power supply, signal gathering, receiving, discriminating, amplifying, etc., elements of present instruments are not very satisfactory, and quite remarkable improvements are possible when the concomitant usefulness can be justified. Striking progress in solid state devices, microelectronics, battery research, etc., undertaken for reasons quite foreign to the problems of blind mobility are, and will be directly applicable.

* This paper was originally written to appear as part of the *Proceedings* of the Rotterdam Mobility Research Conference, published by the American Foundation for the Blind in May 1965. An errata sheet covering this omission, and a change in references of other papers to the omitted paper, will be sent to recipients of the Rotterdam *Proceedings*.

DISPLAY

Thus the central and pervading problem is that of the means of display to the traveler of his environment through sensory modalities ill-equipped relative to the speed, comprehensiveness, and spatial resolution of the human eye. Part of the display problem (and difficult of segregation from the art of beholding) is the discrimination in the field of view of objects of especial and timely interest for the blind man, i.e., the obstacles he must avoid or comply with.

It is our considered opinion that the purely technical aspects of mobility assists - search, size, reliability, etc., but excluding display - are realizable, but not without considerable development time and expenditure of resources for each and every device. The really unresolved questions are the modes and forms of display and the human's reaction to, effective assimilation of, and response to the display. In recognition of this gap we have directed our sensory measurements research to the study of a system by means of which we hope to be able to simulate the essential attributes of the environment-device-man mobility assist situation without our, or others, undertaking the time consuming and expensive detailed design development, and test of specific devices.

MOBILITY AID EVALUATION

A more immediate, but happily closely related problem is that of systematical, rational, and fair evaluation of mobility aids as they become available. The measure of the utility of an aid goes quite beyond a subjective opinion on the part of a user. We need to know how the aid helps the user respond to a great variety of travel situations, how a spectrum of blind travelers of different competences respond to the aid, and how training with the aid enhances its usefullness.

COMPUTER ORGANIZATION OF MOBILITY PERFORMANCE

The data processing capability of a modern high speed computer can, in principle, be organized to maintain a space-coordinate/time record of a human as he negotiates obstacles. The obstacles themselves might not exist physically, but only in the computer's memory of the environment coordinate space. On the basis of input information on the man's position, the computer could be programmed to calculate the man's relationship to the "obstacle." On the basis of criteria defining the characteristics of a simulated detection device the computer could generate a signal which represented the device's interception of the obstacle. This signal could in turn, be presented to the man in some physical fashion, transmitted from the computer by means of cable or radio to a portable display.

Thus, the "device," except for the display, is completely simulated. "Device" search characteristics such as range, field of view, scanning routine, resolution, etc., are determined within the computer by suitable programming, permitting these characteristics to be easily and rapidly altered.

With such a computer centered scheme, systematic tests varying significant parameters of different guidance device concepts could be rapidly, efficiently, and objectively conducted without the expensive, time consuming detailed design, development, and fabrication of each variation of each class of device.

As a by-product of the simulation role the computer provides an invaluable bookkeeping function as an indefatigable, errorless, unprejudiced observer and recorder of the man's effectiveness in coping with the obstacle using this particular setting of this particular class of mobility device. Thus the difficult, time consuming, opinionated, and often ambiguous task of man-device evaluation is regularized and organized.

The combination of the device simulation role and the evaluation recording capability of the computer system suggests the prospects of extraordinary advances in the delineation of design goals and specifications, and the comparison and ranking of the utility of alternative mobility devices. Beyond these direct applications such a system would constitute a powerful research instrument for the study of mobility itself.

SUBJECT TRACKING SCHEMES

In view of the evaluation/bookkeeping promise of this approach, and its obvious extension to training and rehabilitation programs built around device utilization,* we have concentrated thus far on the physical means by which the coordinate position of a subject could be tracked, and the concomitant problem of the computer manipulation of the input so as to provide a record of the subject's path through the obstacle space.

With a view toward the realization of a tracking method and, ultimately, environment/device simulation, compatible with both the evaluation of current (or soon to be realized) devices, we established design goals of:

1) simultaneous tracking of several points on the subject (i.e., head, "mobility device," right foot, etc.);

2) object field large enough to permit realistic situations;

* Note the obvious relationship between this capability and the mobility device program of the Center for Sensory Aids Evaluation and Development described elsewhere (5).

3) feasibility and availability of tracker combined with compatibility with computer input and calculation routine;

4) satisfactory resolution of the geometric and dynamic relationships between man and obstacle;

5) minimum impediment to the subject.

The most promising scheme considered thus far by the Mechanical Engineering Sensory Aids Group at MIT uses a military surplus stabilized platform on which a star tracker is mounted. The star tracker detects an infrared or visible light target attached to points of interest on the subject and provides error signals to the stablized platform devices, which in turn, keep the tracker aligned on the targets on the subject. Resolvers on the platform axes feed angular information into the computer where simple trigonometric calculations generate the x, y, and z coordinates of the path of the target point of interest.

Discrimination among several targets on the man and device - hand, head, etc. - could be accomplished by using different spectral emissions and appropriate filtering, or by means of polarization techniques.

With two such trackers on poles of reasonable height, the path of a subject could be observed over a football field area. A third tracker would provide a redundancy check and insure against tracking loss due to temporary obscuration of the target.

After a study of system requirements by Mr. David R. Stoutemyer, a research assistant conducting the investigation and consultation with faculty and professional colleagues active in inertial and celestial navigation, a military surplus platform has been obtained and experiments with it are under way (7). The equipment presently under development could be used both as the input for a research investigation of man-device display and interaction, and could also be used for the direct evaluation of extant sensory mobility devices.

My colleagues at MIT in Professor Samuel J. Mason's group in the Research Laboratory of Electronics, have taken a somewhat different approach to the tracking problem. Mr. Emanuel Landsman is studying the use of ultrasonic signals with a sound generator si on the subject and three microphones located in the test space. Calculations of the phase shift at the receivers between the ar-rival of the pulses from the subject provides trigonometric data on subject location.

COMPUTER PROCESSING

The computer resolution of tracker input information into the space/time location of the subject is a straightforward problem, as is the generation within the computer of spatial parameters representative of the search pattern of the simulated detection device. The task of instructing the computer to recognize and define the interaction between the "volume" simulating an obstacle and the "volume" swept by the device detector is not trivial, especially when one faces up to problems of resolution, real time calculation, and limited computer memory capacity. The work of Dr. Larry G. Roberts of Lincoln Laboratory, MIT, in programming a computer to display the merging of solid objects is certainly relevant. Mr. R. M. Baecker in Electrical Engineering has also explored this problem (1).

TACTILE AND AUDIO DISPLAY

The computer processing of tracking and detection will permit great freedom in the choice and study of alternative displays and combinations of displays to the human. This part of the overall system must of course be physical since it must interact with the man. But since the signals driving the display will be computer originated it will be easy to preprocess, integrate, or modulate the signal in a wide variety of ways while still in the computer itself. Then the output can be transmitted to the display via cable or telemetry link. Since the display itself will be free of the interconnection and geometry restrictions imposed on a real detection device, it can tend toward a universal capability rather than being warmly specific. One can visualize spatially discributed tactile transducers operable at different frequencies, pulse rates, amplitudes, etc., combined perhaps with monaural and binaural audio displays, again with variable frequency, amplitude, phasing, etc., coding capability.

In the final analysis, this is the heart of the mobility problem. How does one impedance match a remaining sensory modality of a human being, or some combination of modalities, with a stimulation so as to provide the most satisfactory characterization of his environment to a blind man?

THE MAN-MACHINE SYSTEM

Armed with his display and confronting his imaginary obstacles, the man completes the loop - from the man held simulated detection device, to computer, to display, and then through the man's reaction to his presumed obstacles back to the computer via the tracker.

The overall simulation scheme presents an enormous increase in our ability to understand and master the problems of blind mobility. But it must also be noted that the realization of the comprehensive plan represents a very large effort and the deployment of very substantial resources. The work currently under way must be recognized as fragmentary and explorative, a search to define feasibility and the optimum methods for handling components of the overall system. In light of the necessarily progressive nature of the study, it is especially important, I believe, that the design be carried forward in such a way that elements of the system have utility of and by themselves, especially as described earlier in the context of evaluation of real mobility aids already with us, some of which were described and demonstrated at the Rotterdam Mobility Research Conference.

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