THE ROLE OF AUDIOMETRY IN THE PREVENTION OF OCCUPATIONAL DEAFNESS

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A Thesis submitted for the Degree of
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SUMMARY

The research set out to test three main hypotheses derived from a summary of literature relevant to the use of audiometry in industry. These hypotheses were: (1) performing audiometry increases the probability that hearing protectors, once issued, will be worn; (2) audiometry is considered by workers to be evidence of their employer's concern for their welfare; (3) audiometry is associated with common law claims by workers against employers for alleged occupational deafness. Six subsidiary hypotheses were also developed. Four methods of data collection were used: (1) attitude questionnaires were administered to samples of workers drawn from an industrial company performing audiometry and two industrial companies not performing audiometry; (2) a postal questionnaire was sent out to industrial medical officers; (3) surveys were undertaken to assess the proportion of the workforce in each of eight industrial companies that was wearing personal hearing protectors that had been provided; (4) structured interviews were carried out with relevant management level personnel in each of five industrial companies. Factor analysis was the main statistical analytic technique used. The data supported all three main hypotheses.

Audiometry was also examined as an example of medical screening procedure. It was argued that the validation of medical screening procedures requires the satisfaction of attitudinal or motivational validation criteria in addition to the biological and economic criteria currently used. It was concluded that industrial audiometry failed to satisfy such attitudinal or motivational criteria and so should not be part of a programme of screening for occupational deafness. It was also concluded that industrial audiometry may be useful in creating awareness, amongst workers, of occupational deafness.

It was argued that the only profitable approach to investigating the role of audiometry in preventing occupational deafness is to study the attitudes and perceptions of everyone involved.

ATTITUDE

AUDIOMETRY

HEARING PROTECTORS

SCREENING

CONTENTS

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SECTION 1: GENERAL INTRODUCTION

CHAPTER 1

BACKGROUND TO THE RESEARCH

1.1 The Development of Interest in Noise-Induced Hearing-Loss

It has been known for many years that deafness can be caused by excessive noise. Ramazzini (1713) referred to prevalence of deafness amongst the metalworking trades of Egypt. This awareness has grown over the years and, as a result, the twin desires of understanding the relationship between noise and deafness and developing methods of preventing such deafness, have grown also. A letter to The Lancet in 1854 asked if readers knew of any way of preventing the deafness resulting from game-shooting. The reply received was to stop the ears with cotton wool.

The first serious attempt to study noise-induced deafness (more appropriately called noise-induced hearing-loss), was by Barr (1886) who compared boiler-makers with other groups of workers in less noisy jobs. To assess the degree of hearing-loss of his subjects, he used the somewhat crude method of holding a ticking watch a fairly long distance away from the subject's ear and gradually bringing it closer and closer until the subject reported that he could hear it. The units of measurement were inches of hearing, that is, the less the hearing-loss of the subject, the more inches away from his ear was the point at which the ticking watch could first be heard. The possible uncontrolled variables in this method are legion. Nevertheless, Barr was able to describe the major characteristics of occupational hearing-loss as we know them today.

The early years of research were hampered by a lack of descriptors of the physical properties of sounds, a lack of methods for producing sounds in an adequately controllable manner, and a lack of understanding of the ranges of sounds that the human ear could respond to. Much early work was thus aimed at filling these gaps in knowledge and it was out of the need to find methods of producing controllable sounds that audiometry developed.

1.2 The Development of Industrial Audiometry

Audiometry is the testing of hearing acuity and an audiometer is a device for producing sounds of pre-determined frequency and intensity within a known tolerance range. The very earliest audiometers were mechanical devices such as Politzer's "acoumeter" described first of all in 1877 (Politzer 1877). The modern audiometer, though, is an electrical device based upon the electrical audiometers which were made possible by Alexander Graham Bell's invention of the telephone in 1875. The first electrical audiometer was that invented by Hartmann in 1878 (Hartmann 1887) which, after Politzer's practice he called an acoumeter. The first *electrical* audiometer to be called an audiometer (though not the first *device* to be so-called) was that introduced by Hughes in 1879 (Hughes 1879). Audiometers were developed for the purpose of investigating the dynamic characteristics of sound and hearing in a research setting and it is a small step from there to the use of audiometry for establishing hearing acuity norms against which to assess hearing-loss. The use of audiometry in a medical setting to identify individuals with abnormal hearing and assess their degree of hearing-loss subsequently developed, and was introduced into noisy industries to assess hearing damage and facilitate preventive action. Use of audiometry in this setting began first in the United States of America. The earliest reference that could be found is Bunch (1937) who suggested that employees should be tested before and during employment for research purposes, but who doubted this would happen because of the cost in money and manpower. He went on to say:

> "There are probably two reasons why extensive programs (sic) of repeated tests in industries have not been established. First the employer is inclined to discourage such an investigation because of the possibility of legal regulations. Recently an employer, when asked what his reaction would be to such a program in his factory, replied, "My first reaction is to let sleeping dogs lie". Second the employee himself may oppose it for fear some handicap may be made known and his tenure be made insecure. We are informed that there is one exception to this. *Certain railroads require frequent examinations of the hearing of employees who are responsible for the safety of the public*."
>
> (RJM's italics)

This is also the first reference that could be found to the possibility of controversy attaching itself to the measurement of hearing in industry. Audiometry spread to the United Kingdom much later. (No reference could be found which pinpoints the earliest date, but from interviews conducted with industrial medical officers and others, it would seem that the use of audiometry in British industry began to develop in the first half of the 1950's.)

1.3 The Development of a Relation Between Noise and Hearing-Loss

Methods for preventing noise from damaging hearing had also been developed over the years and were mainly of two types; noise control and personal hearing protection. The former means either reducing the amount of noise produced by machinery, or isolating it in some way. The latter means protecting workers individually by providing them with ear plugs or ear muffs. Such methods could only be applied blindly because how much hearing-loss was likely to be caused in how many people by how much noise was not known. That is to say, there was a lack of dose-response and epidemiological data. As a result if was felt that hearing levels should be tested on a regular basis for workers exposed to noise in order to assess the effectiveness of preventive measures.

In 1962, a project sponsored jointly by the Medical Research Council and the National Physical Laboratory was set up to furnish this knowledge. In 1968 it reported the very simple, but important, conclusion that the amount of hearing-loss suffered by a population could be predicted from the amount of noise energy received by the ear over a working lifetime (Burns and Robinson 1970). The project succeeded in demonstrating a relation between noise and hearing-loss so that it is now possible to predict what proportion of a working population will sustain a certain minimum amount of hearing-loss if the noise levels and the length of exposure to them are known. This knowledge enabled the Department of Employment to lay down guidelines for the protection of workers against noise-induced hearing-loss (Department of Employment, 1972). Thus, it is now possible to predict the outcome on hearing-loss of any noise control attempt or personal hearing protection programme (provided steps are taken to ensure that hearing protectors are worn properly by the people they are issued to) without the need for audiometry. Indeed, the code of practice just referred to specifically excludes audiometry in its guidelines.

1.4 The Continued Use of Audiometry by Industry

Nevertheless, audiometry is still being performed in many British firms and it would appear that it is not simply a case of existing audiometry programmes continuing, but of new ones being initiated. By the same token many firms do not perform audiometry and a controversy has developed concerning the use of audiometry in industry. (The literature relating to this controversy will be reviewed later). The question that needs to be asked, therefore, is why is audiometry being performed or not performed in industry, whichever the case may be? As was implied by earlier points in this section, the history of industrial audiometry is the history of a technique used as a part of medical practice and the majority of the people involved in audiometry and the controversy surrounding it are industrial medical officers. This may give an insight into the reason for the survival of audiometry in industry. From what has been said earlier, the knowledge gained by Burns and Robinson (1970) can be used to predict what will happen to a population under certain conditions, but not what will happen to any individuals within that population. This is because of the probabilistic nature of the relationship discovered and the essentially arbitrary nature of the noise-exposure limits recommended by the Department of Employment's code of practice. (This limit is an attempt at a balance between degree of risk and reasonable practicability of various solutions). In addition, noise control and personal hearing protection are engineering solutions (although medical supervision may be necessary in the latter case) and may not commend themselves to medical practitioners who have the responsibility of caring for individuals. But is it true that audiometry allows the individual worker to be protected effectively? This is a question that requires investigation.

A corollary of the question why is audiometry performed or not performed in industry is the question, should audiometry be performed in industry? From what has been said so far the answer is not clear, but this is the question that is likely to be asked by an individual company with a noise problem (i.e. should our company perform audiometry upon our workers who are exposed to excessive noise?) Many companies may look towards government agencies for guidance, especially as the Department of Employment has issued the code of practice referred to earlier. One Government body which could wish to provide such guidance is the Employment Medical History Service, (E.M.A.S.).

The E.M.A.S. was established by the Employment Medical Advisory Service Act 1972. This Act was amended by Part II of the Health and Safety at Work etc. Act 1974 such that part of the purpose of the E.M.A.S. is defined as being to secure "that the Secretary of State, the Health and Safety Commission and others concerned with the health of employed persons or of persons seeking or training for employment can be kept informed of, and adequately advised on, matters of which they ought respectively to take cognizance concerning the safeguarding and improvement of health of those persons;" (Health and Safety at Work etc. Act 1974, Part II, section 55(i)(a)). This can be interpreted as obliging the E.M.A.S. to (a) advise companies on questions such as whether or not they should perform audiometry if they are to best protect workers exposed to excessive noise, and (b) to obtain the best information possible in order to provide such advice. If relevant questions cannot be answered directly, then indirect questions should be attempted. In the context of the present discussion, the direct questions, from the point of view of companies, industrial medical officers and the E.M.A.S. are "should audiometry be performed at all in industry?" and "does audiometry provide for the effective protection of every individual worker as opposed merely to groups of workers on a probabilistic basis?"; and the indirect question is "why is audiometry performed or not performed in industry as the case may be?"

1.5 The Objectives of the Thesis

The first objective of the thesis is to try and answer the questions:-

> "should audiometry be performed at all in industry?",
>
> "does audiometry provide for the effective protection of every individual worker as opposed merely to groups of workers on a probabilistic basis?",
>
> "why is audiometry performed or not performed as the case may be?".

Such answers should, hopefully, be useful to the E.M.A.S., to industrial medical officers, and to the relevant decision-makers in industry.

Subservient to this objective is that of producing a comprehensive review of the literature relevant to the industrial use of audiometry. A literature review is obviously necessary but, for the present purposes, it is intended to show that the evidence relevant to audiometry largely pertains to technical parameters of the technique while the polemics surrounding industrial audiometry turn upon the problem of whether a programme of audiometric testing is worthwhile or not.

Following on from this the next major objective of the thesis is to demonstrate that, in the area of industrial audiometry, a more worthwhile focus of research effort is not the technique of audiometry, but the people involved in its use. These people include those involved in making the decision to employ audiometry (that is, medical officers, managers, and so on) and those on the receiving end of whatever audiometry implies (that is, workers). Thus it is intended to show that if worthwhile statements are to be made about the use of otherwise of audiometry, then it is necessary to investigate the perceptions of the benefits or harm accruing from it that are held by the decision-makers in industry and also the perceptions held by the workers themselves. Thus it is intended to show that the most fruitful research approach is an indirect, attitudinal type of approach. It is also intended to argue from this that such an approach may be worthwhile throughout industrial decision-making because the assumption that such decision-making is made on purely rational bases may not always be justified.

Another major objective of the thesis is to examine industrial audiometry as an example of a medical screening procedure. The purpose of this is twofold:-

(a) to show that the two types of criterion presently established for the validation of medical screening procedures (the biological and economic types of criterion) are insufficient and that a third type of criterion (motivational or attitudinal) is needed as well; and

(b) to examine the extent to which industrial audiometry satisfies the criteria in general and the third type of criterion in particular. Thus it is intended not only to make statements about audiometry itself, but also to make statements important to the field of medical screening and its interaction with those who use it and its target populations.

1.6 Plan of the Thesis

The thesis is divided, overall, into four sections. Section 1 deals with the background to the research while Section II is concerned with the methodology of the research to be reported in this thesis. Section III is the presentation of the results and Section IV covers the discussions arising from these results. The thesis is also divided into nine chapters such that each section consists of a number of these chapters.

Chapter 1 (of which this sub-section is a part) outlines the historical development of the interest in industrial audiometry and details the objectives of the thesis.

Chapter 2 begins by discussing the literature relating to studies of relevance to industrial audiometry. The majority of these studies concern various aspects of the reliability of audiometry as a test of hearing acuity. From this literature the uses to which many propose audiometry be put in industry are categorised. It is argued that most of these uses can be regarded as examples of industrial audiometry's being employed as a medical screening procedure. The validation of medical screening procedures is discussed both in general and with reference to audiometry in particular. Finally, the use-categories are discussed individually in the context of literature expressing opinions (as opposed to scientific studies) relevant to each.

Chapter 3 develops the problem to be investigated by first of all identifying the claims that are made for the usefulness of performing audiometry in industry and then discussing approaches to the investigation of these claims. The relevance of these claims and approaches to audiometry as a medical screening procedure is discussed as is the relevance of the acceptability of personal hearing protectors to workers. It is then argued that an attitudinal or motivational type of criterion is necessary for the evaluation of medical screening procedures in addition to the presently accepted criteria. An attitudinal type of research approach is selected as being most appropriate and hypotheses for testing are extracted from the preceding discussions of the literature.

Chapter 4 (the first of Section II) outlines the research strategy to be used and describes how the research tools were developed and how some of the practical problems encountered were overcome. The major analytical tool used was factor analysis and so this statistical technique is described in some detail in terms of what it does, how it is used, and some problems associated with it.

Chapter 5 describes the detail of the method, that is, the techniques that were used, the samples of respondents, and the types of analysis that were performed.

Chapter 6 (the first of Section III) details the results of the research while Chapter 7 discusses these results in terms of the limitations that can be placed upon them in the drawing of conclusions relevant to the hypotheses under test.

Chapter 8 (the first of Section IV) lists these conclusions and discusses them first in terms of their implications for the hypotheses being tested and what they imply for the field of occupational health and safety matters in general, and then in terms of their relevance to the validation of medical screening procedures. This discussion of medical screening procedures is approached both in general terms and in terms specific to audiometry as a medical screening procedure. The chapter ends with a summary of the outcome of the research.

Finally, Chapter 9 discusses possible avenues for further research in industrial audiometry, decision-making processes in industry, the evaluation of hearing conservation programmes, the attitudinal and perceptual climate of industry, the validation of medical screening procedures both generally and specifically with regard to industrial audiometry, the importance of human factors as opposed to techniques in health and safety, and sundry other directions.

CHAPTER 2

A REVIEW OF THE LITERATURE

2.1 A Glossary of Terms

1.	Evidence.	This is taken to mean data from controlled studies of various aspects of audiometry that are relevant to its use in industry.
2.	Decibel.	The unit of SOUND intensity or sound pressure level. It is abbreviated to dB.
3.	Hertz.	The unit of frequency or pitch of sounds. It is abbreviated to Hz or kHz in the case of Kilo Hertz.
4.	Manual Audiometry.	This refers to audiometry in which the presentation of the test tones is under the control of the audiometric operator.
5.	Automatic or Self-recording Audiometry.	This refers to audiometry in which the test tones are presented automatically by the audiometer, once the operator has set it up. The usual sequence of testing is to present a tone at a fixed low frequency, test hearing at that frequency for a fixed time-period (usually 30 seconds) and then change automatically to a higher frequency for the same time-period and so on. Normally 6 to 8 frequencies are tested. The left ear is tested first throughout the whole frequency range and then the right ear is so tested.

		This form of audiometry is often called Bekesy audiometry. Technically, this is incorrect because, strictly speaking, Bekesy audiometry refers to audiometry in which the frequency of the tone being presented is increased continuously as the test progresses rather than in the stepwise fashion described above ("sweep"-frequency testing as opposed to "fixed"- or "discrete"-frequency testing). The term Bekesy audiometry will not be used in this thesis except in the technical sense.
6.	Pure-tone.	This is a sound in which only one frequency is present (as opposed to most sounds which consist of many frequencies together).
7.	Air-conduction.	The normal unimpeded passage of sound to the hearing mechanism of the Inner Ear.
8.	Bone-conduction.	The passage of sound to the Inner Ear via the bones of the skull.
9.	Audiogram.	The chart of hearing threshold levels resulting from an audiometric test.
10.	Threshold of Hearing.	The smallest intensity of sound that can be heard at any given frequency.

A number of studies have been performed in order to compare manual and automatic audiometry (for example, Robinson and Whittle, 1973). The general outcome is that the difference between hearing thresholds obtained by the two techniques is negligible. However, in the studies of audiometric reliability that are about to be reviewed, the type of audiometric technique used will be indicated.

2.2 Studies of Audiometric Reliability

> "There are medical folders in plant dispensaries in which at least 30% of the audiograms are neither valid nor reliable. This could be due to tester or testee "mistakes"."
>
> (Sataloff and Vassallo 1973).

An almost identical quotation can be taken from Sataloff (1974). Leaving aside the accuracy of the figure quoted, it is apparent that the ability of audiometry to obtain consistent results from an unchanging individual is vitally important. It is, therefore, necessary to look at the findings from studies of audiometric reliability or variability or repeatability.

One of the earliest studies to investigate the magnitude of audiometric variability was that of Brown (1948) who investigated variability due to using different audiometric measuring systems (manual audiometer, booth, and operator considered together as one unit) using different operators, and learning or practice. For each of these comparisons he used a group of 30 subjects which included both normal-hearing and hard-of-hearing individuals though not the same group in each case. The statistics used were the t-test, the product-moment correlation co-efficient, and the standard deviations of the differences between subjects' test and retest audiograms. Brown concluded that the two audiometric measuring systems used in his study showed very close agreement with one another as did the two operators employed. He also concluded that no practice effect existed. These conclusions are based upon the high test-retest correlations obtained (for the entire study the highest value was 0.97, and the lowest was 0.86) and the failure of 20 of the 21 t-tests performed (three comparisons at each of seven frequencies) to reach significance at the .05 level. However, these statistics are inappropriate for these types of comparison. Product-moment correlation is a measure of relative agreement between tests and a high test-retest correlation, while indicating good agreement between tests does not preclude the possibility of an absolute test-retest difference occurring from one subject to another. (This did not happen in Brown's study, but that does not invalidate the argument for the general case.) The t-test is a test of the difference between group means and so a non-significant t-test does not preclude the possibility of great individual subject variability. The Measure of such variability or disagreement between tests is the standard deviation. (If the standard deviation is squared, then the variance is obtained. This is the statistic I shall be using throughout). In his comparison of audiometric measuring systems (experiment I) Brown obtained variances ranging from 35.64 $(dB)^2$ at 512 Hz to 98.60 $(dB)^2$ at 8,192 Hz. In his comparison of operators (experiment II) the range of variances was 26.01 $(dB)^2$ at 128Hz to 47.61 $(dB)^2$ at 8,192 Hz. Finally, in his practice effect investigation (experiment III), he obtained variances ranging from 19.01 $(dB)^2$ at 512 Hz to 50.41 $(dB)^2$ at 8,192 Hz. This indicates that individual variability between tests is high. It is notable that Brown was aware of the implications of this for retesting individuals for he suggests that, working to the nearest unit of 5 dB, differences greater than ±10 dB should occur between measurements at any frequency before it can be concluded that a change in the subject's hearing has taken place. If the tests have taken place on different, but similar, systems, then the critical difference should be ± 15 dB he suggests.

This study is important in several respects. One is that it highlights the difference between comparisons of individuals with themselves and comparisons of groups with themselves. Another is that it showed that the distribution of test-retest differences is not skewed when real changes in hearing-level due to noise, age, progressive pathology or whatever are not present. (This result was also found by Waldron (1959) with a sample of air-craft and engine maintenance men). This is crucial if group means are to be compared meaningfully. Thirdly, the study may be regarded as definitive in that it investigated the major "human element" sources of variability that have interested subsequent investigators. These are intra-subject variability, inter-operator variability, and differences due to practice or learning. However, Brown was concerned with audiometry used in a clinical rather than industrial setting, so for the remainder of the discussion of audiometric reliability studies, those studies dealing with industrial audiometry will be concentrated upon. That such an approach may have more than just face validity is suggested by the finding by Robinson and Burdon (1970) that intra-subject unreliability tends to increase as the noise-exposure of subjects increases. Nevertheless, reliability studies using non-industrial samples as well as those studies centred upon industry will be included in the summary table (Table 1) at the end of

High and Glorig (1962) took two audiograms, using an automatic audiometer from 79 subjects employed in three manufacturing concerns, the test-retest interval being approximately six months. All the subjects were selected from low noise-exposure jobs in order to eliminate contamination of test results by noise-induced temporary threshold shift. No other selection criteria were used. High and Glorig found that the variances of the test-retest differences ranged from 13.32 $(dB)^2$ at 2,000 Hz in the right ear to 29.39 $(dB)^2$ at 6,000 Hz in the left ear. (In fact standard deviations were used but these have converted these to variances as explained earlier). They concluded that "reliability of measurement of the order found in this study would appear to be adequate for most of the purposes to which industrial audiograms are put." Atherley and Dingwall-Fordyce (1963) obtained four manual audiograms from each of twelve otologically normal young men. They found the variance of these repeated measurements to be 8.5 $(dB)^2$ at 500 Hz, 6 $(dB)^2$ at 3,000 Hz and 23 $(dB)^2$ at 8,000 Hz with differences between consecutive same-frequency threshold determinations extending up to 25 dB. They concluded that in order for differences in threshold as revealed by consecutive audiograms to be considered statistically significant at the .01 level, then they should be between 10 and 17.5 dB, depending upon frequency, if a single ear is being considered. If a change of similar magnitude occurs at the same frequency in both ears simultaneously, then in order to be statistically significant at the .01 level, this change should be between 7.5 and 12.5 dB, once again depending upon frequency. These values are given to the nearest 2.5 dB unit. It is interesting that while the test repetition variances discovered by Atherley and Dingwall-Fordyce (1963) are slightly smaller than those discovered by High and Glorig (1962), the probability analysis performed by the former throws doubt upon the practical reliability of industrial audiometry. In the light of High and Glorig's conclusion, this begs the question of the uses to which audiometry is put in industry. This will be dealt with later in this chapter.

Howell and Hartley (1972) studied the initial and repeat audiograms from two operators of 143 young male workers not previously exposed to noise at work (i.e. new entrants to industry). Manual audiometers were used. They discovered that for nearly half the subjects tested, differences between audiograms obtained by the two operators amounted to 5 dB or more with differences extending up to 21¼ dB. Each operator compiled a list of men in the lowest decile of hearing levels. Only half the names were common to both lists. Howell and Hartley interpret this as evidence of great inter-operator variability which must reduce the reliability of audiometric measurements. They point out that there is no reason to suspect that the two operators used represented the extremes of a continuum.

Hartley et al. (1973) examined intra-subject variability by comparing the repeat audiograms of 132 apprentices (mean age 16 years) at two factories using a manual audiometer at each and found mean differences, averaged over both ears, of up to 5.2 dB at 1,000-2,000 Hz averaged and 5.8 dB at 3,000-4,000 Hz averaged. They found differences of up to 10 dB at 1,000-2,000 Hz averaged and 12½ dB at 3,000-4,000 Hz averaged. At a third factory they studied, they studied the repeat audiograms of 45 men (mean age 36 years) using a self-recording (Bekesy) audiometer, but the only figure they give is the mean difference between three audiograms averaged over 1,000-2,000 Hz and both ears. This mean difference was 4.5 dB. Hartley et al. interpret their results as being evidence of intra-subject unreliability to an extent which may make single audiograms misleading.

An American study by Gosztonyi et al. (1971) looked at 100 personnel in heavy industry in terms of the parameters of intra-subject variability, inter-operator variability and manual-automatic audiometry differences. The results obtained were obviously complex and were further complicated by the fact that a comparison was also made between salaried and hourly-paid employees. The comparisons were made on the basis of speech frequency (500, 1,000 and 2,000 Hz) means. They discovered that mean differences obtained from the various comparisons that could be made amongst these parameters ranged from 8 dB to about 15 dB and that the range of individual differences was the startlingly large one of -22 to +53 dB. (These are the greatest limits found amongst the various comparisons made). Taking as a criterion of unreliability differences of more than 10 dB, Gosztonyi et al. found 17 out of 50 audiograms (34%) taken in a particular area to be unreliable. They also found that automatic audiometry produced greater variability than manual audiometry, particularly in hourly-paid workers.

In contrast to these enormous differences, Pelmear and Hughes (1974) found that mean differences between initial and repeat audiograms of 118 drop-forge employees in the age range 18-64 years varied from -0.47 to +0.61 dB. They tested the frequencies 500, 1,000, 2,000, 3,000, 4,000 and 6,000 Hz using a self-recording audiometer, but, unfortunately, they do not say how many operators were used. They also found the largest standard deviation to be 6 dB at 6,000 Hz and the smallest to be 3 dB at 2,000 Hz. They conclude from these results that a single self-recorded audiogram is quite reliable. Note, however, that standard deviations of 3 dB and 6 dB mean variances of 9 $(dB)^2$ and 36 $(dB)^2$ respectively. These variances are higher than those reported by Atherley and Dingwall-Fordyce (1963) who yet arrived at the opposite conclusion to that of Pelmear and Hughes. Also, the ratios of the standard deviations obtained by Pelmear and Hughes to their mean differences are large, suggesting that while most individuals were consistent some were considerably inconsistent. This supports the trend which seems evident in the studies so far reviewed.

Robinson et al. (1973) set out to investigate various parameters of what they called "subjective error" in automatic audiometry. They employed 147 volunteer subjects from a knitwear factory and tested the same frequencies as Pelmear and Hughes above. They found that the vast majority of subjects produced repeatable (i.e. reliable) audiograms. However, they found some subjects whose repeatability was poor. To quote from their conclusions, "the performance of subjects who exhibit large errors at first test seems impervious to deliberate attempts to improve it". This confirms the trend noted in the earlier studies and was also noted to a larger extent by Burns and Robinson (1970)

Robinson et al. also observed that an appreciable learning effect occurred over the four audiograms taken. That is almost all subjects produced better threshold levels with practice. This learning effect has been noticed in other studies. Delany (1970, 1971) using automatic audiometry noticed that subjects were still improving after 10 audiograms even though well practiced in audiometry. Robinson and Whittle (1973) (referred to earlier) noted even larger effects with highly-motivated, but untrained, subjects. Robinson et al. themselves, comment that "...(learning) effects, sometimes exceeding the bounds of credibility, are found when the audiometry is carried into the industrial field". (Note that Robinson et al's. subjects were all volunteers). Also, in their own study, Robinson et al. found that if there was a long break (in this case a week), subjects showed a slight relapse in their performance. Such phenomena are well known from studies of the psychology of learning and human performance and has obvious implications for any serial audiometry programme.

Finally, Stephens (1971) studied the relationships of two personality dimensions (introversion-extraversion, and neuroticism) to hearing thresholds obtained by self-recording audiometry. He found no relation between these personality dimensions and absolute hearing threshold, but found that they correlated with intra-subject variability. As yet, though, we know nothing of the correlates of individual differences in unreliability other than this and suggestions arising from the work of Gosztonyi et al. (1971) and Robinson et al. (1973). The former found manual workers to be far more unreliable in repeated threshold determinations than salaried personnel while the latter found that this effect was virtually non-existent except that the most unreliable results came from manual workers.

2.2.1. Studies on the Achievement of More Reliable Threshold Measurement.

The point that audiometry requires a higher standard of safeguard against unreliability in some circumstances appears to be generally accepted, and so interest has been focussed upon ways of achieving this higher standard. The method that has won acceptance is the simple expedient of performing more than one audiogram and averaging them to obtain the mean hearing level. Obviously, assuming the variability is random - a reasonable assumption when dealing with individuals - if enough audiograms are taken then, sooner or later, a stable and reliable mean will emerge. Two questions arise from this, how many audiograms need to be taken, and how many sessions are required so as to obtain this number without unduly fatiguing the subject? Burns (1968) suggested that the mean of two or three readings taken within a short interval of time, should be used. Burns and Robinson (1970) suggested that the mean of three audiograms, taken at three separate sittings with a week between each should be taken. This should, it was claimed, reduce variability by half. Hartley et al. (1973), in the study discussed earlier, looked at this problem by comparing the results of three audiograms taken at one sitting with the results of three audiograms taken in the manner suggested by Burns and Robinson (1970). They discovered no significant difference either between the means or between the variabilities of each procedure. They also discovered that in most cases, the second audiogram obtained did not vary significantly from the mean of all three and so they suggested two audiograms be taken at a single session and that, in the absence of significant differences between them - they suggest 5 dB - then the second audiogram should be adopted as the true one. The implication is that in the presence of significant differences, three audiograms should still be taken and averaged. However, this implication appears to have been missed by many readers of Hartley et al's. report (Howell (1974), personal communication). For example, Ensell (1973) writes:

> "I was heartened to see the paper by Hartley et al. because for many years we have been impressed by the reproducibility of audiograms. So long as there is a competent operator and a fully sound-proofed comfortable booth, a single estimation is all that is apparently necessary."

Note that in this case, the entire paper by Hartley et al. has been misinterpreted.

The study mentioned earlier by Robinson et al. (1973) indicated that repeat testing was necessary in order to approach reasonable accuracy and so the same workers (Robinson et al. (1975)) compared three audiograms taken at a single sitting with three audiograms taken on successive days. The subjects were 223 employees working at London (Heathrow) Airport and were divided into two approximately matched groups. They concluded that a single extended test session is preferable to a series of shorter tests.

These studies do nothing more than tell us that audiometry conducted at a single session is preferable to spreading it over several sessions and they provide no answers to the two questions posed earlier. They add nothing more to what was stated to be obvious previously, namely, the more tests done, the more reliable the results. Of course, there are some who maintain that a single audiogram is adequate (e.g. Ensell (1973), Pelmear and Hughes (1974)), but this contention is based upon the observation that a majority of testees produce consistent results. The majority of testers would prefer to obtain a reasonable audiogram from *all* testees. This is approaching the most that scientific enquiry can offer in the way of reliability studies.

2.3 The Cost of Industrial Audiometry

However, apart from such reliability studies, little else of an evidential nature appears to have been done that is relevant to industrial audiometry. The little that has been done relates to the cost of industrial audiometry and (of particular relevance to screening audiometry which will be discussed more fully later) to the incidence of false positives (individuals wrongly identified as possessing a hearing-loss) and to the validity of audiometry as a predictor of social disability. Studies of the cost of performing an audiogram are dubious until firmly agreed costing assumptions are decided upon. This does not appear to be the case at the moment with the result that estimates of cost per audiogram vary widely. For example, Bruton (1974) in a study at Heathrow Airport calculated a figure of 64p per audiogram while Jauhianinen (1973) in a study in Finland obtained a figure of 10 Sw.Kr. (95p approximately) per audiogram. The very much higher figure of £3.00 per audiogram was reached by Stone (1974). Regarding the false positives and social disability studies, a number of studies relevant to the latter aspect exist, but very few relevant to the former.

In fact the only published work found that gives figures on this is the study performed by Jauhiainen (1973) mentioned above who gives a 0.7% false positive rate in an industrial survey, but gives no indication of how this figure was derived No figures are available at all for false negative rates, but it is difficult to see how any could be obtained from an industrial audiometry programme. This is particularly unfortunate since false negatives, for their own protection in a programme which relies upon audiometry, are in greater need of detection than false positives. False positive is essentially fail-safe, while false-negative is fail-dangerous. Also false positive and negative rates are a function of screening criterion. This is of particular importance when "normals" and "abnormals" are part of the same distribution, as is the case with hearing-loss.

2.4 Audiometry as a Predictor of Social Disability

The level adopted as the screening criterion is decided upon on the basis of predicting social disability. Now, in industry we have the possibility of two major aims being followed in relation to screening out individuals on their way towards social disability. The first is the medical consideration of predicting those individuals likely to become socially disabled so that appropriate steps can be taken and the second is the medico-legal consideration of compensation for hearing-loss. Germane to the first consideration is the question of the validity of pure-tone audiometry as a predictor of social disability or the inability to adequately understand human speech. Noble and Atherley (1970) compared a number of indices of social disability resulting from hearing-loss and concluded that the pure-tone audiogram gave only a partial picture of social disability in a noise-exposed industrial population. Noble (1973), in a review of 23 published reports, concluded that pure-tone audiometry has not been validated as an adequate test of inability to understand speech.

TABLE 1 A Survey of Studies Performed to Investigate Various Aspects of Audiometric Reliability.

Results are expressed in terms of the variance of repeated tests except where otherwise stated. The studies marked with an asterisk used frequencies based upon multiples and sub-multiples of Middle C (256 Hz) instead of multiples and sub-multiples of 1,000 Hz as the other studies reported are based upon. The studies are presented in chronological order.

TEST FREQUENCIES (IN HERTZ)

VARIANCES IN $(dB)^2$

AUTHORS	80	125	250	500	1000	1500	2000	3000	4000	6000	8000	12000	COMMENTS
Steinberg & Munson (1936)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects: "A large group" varying in age and sex.Studied loudness judgements at 100, 1,000 and 5,000 Hertz.Concluded that earphone position and fit could account for standard deviations of as much as 5-7 dB (Variances 25-49 $(dB)^2$ .Manual Audiometry.
Munson* (1937	-	-	12.25	18.49	16.00	-	18.49	-	34.81	-	96.04	-	Subjects: 38. Used the same audiometer and operator on all subjects. Only one retest. Manual Audiometry.
Good-fellow* (1938)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects: 5. Tested subjects daily for 3 wks. Expressed results in terms of hearing threshold levels. Found repeat thresholds to vary "considerably". Manual Audiometry.
Witting* and Hughson (1940)	NORMAL GROUP												Subjects: 17 hard-of-hearing patients with various otological disorders plus 7 normal hearing subjects. Took 126 audiograms from the normal group and 297 from the hard-of-hearing group.Found the average of 3 audiograms to be much more reliable than a single audiogram.(93.1% within ±5 dB of the overall average as opposed to 76.7% of single audiograms).Manual Audiometry.
	-	11.16	9.67	7.51	9.99	-	7.84	-	13.91	-	20.25	-	
	HARD-OF-HEARING GROUP												
	-	21.53	19.80	15.05	10.76	-	15.29	-	17.89	-	21.81	-	

	80	125	250	500	1000	1500	2000	3000	4000	6000	8000	12000	
Currier* (1943)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects:The author plus a colleague. Concerned with the effect of ambient noise upon clinical audiometry performed in consultant's office.Took 6 audiograms from each subject.Expressed results as hearing level differences.Found 98.8% and 95.8% respectively of all audiograms to be within ±5 dB. Manual Audiometry.
Harris* (1945)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects: 4 groups containing 64,120, 150 and 72 males respectively.Mostly normal hearing.By implication all subjects were military though this is not stated explicitly.Compared group audiometry with individual audiometry. Assumed latter to be adequately reliable.Found group audiometry to be almost as reliable though reliability decreased if earphones were moved or changed. Manual Audiometry.
Carrell and Gormley (1946)	-	-	-	-	-	-	-	-	-	-	-	-	A general review of studies on various aspects of the validity and reliability of diagnostic audiometry. Concluded from the studies of Witting and Hughson (1940) and Currier(1943) that two consecutive audiograms could theoretically vary by 10 dB.
Gardner* (1947)	TECHNIQUE A, Normal												Subjects: 6 normal, 5 impaired hearing. 5 of these 11 were experienced listeners, 6 were naive. compared two types of manual audiometry
	-	-	10.89	7.84	6.25	-	5.76	-	8.41	-	25.00	-	
	TECHNIQUE A, Impaired												
	-	-	9.61	6.25	5.29	-	8.41	-	11.56	-	12.25	-	
	TECHNIQUE B, Normal												
	-	-	6.76	2.89	6.25	-	7.29	-	9.00	-	19.36	-	
	TECHNIQUE B, Impaired												
	-	-	5.29	4.41	3.61	-	2.89		12.25	-	10.24	-	

		80	125	250	500	1000	1500	2000	3000	4000	6000	8000	12000	
Brown* (1948)	EXPERIMENT I	-	68.72	43.16	35.64	48.30	-	42.51	-	37.82	-	98.60	-	Subjects: Experiment I, 6 normal and 24 impaired hearing;Experiment II, 7 normal and 23 impaired.Investigated inter-measuring system, inter-operator and intra-subject (called practice by Brown) variability. Manual Audiometry.
	EXPERIMENT II	-	26.01	43.56	39.06	42.25	-	34.22	-	27.04	-	47.61	-	
	EXPERIMENT III	-	34.81	27.67	19.01	33.87	-	20.25	-	28.73	-	50.41	-	
Harris* and Myers (1952)	DAILY JB		-	2.99	-	2.99	-	-	-	-	-	17.98	-	Subjects: 3 normal-hearing men aged 35 to 39 years in a study of day-to-day and week-to-week threshold variablity. Presented data for each subject separately. Subjects referred to by the letters JB, CG, and SS. Manual Audiometry.
	DAILY CG		-	3.03	-	3.50	-	-	-	-	-	6.87	-	
	DAILY SS		-	2.46	-	5.15	-	-	-	-	-	5.90	-	
	WEEKLY JB		-	1.37	-	3.17	-	-	-	-	-	8.76	-	
	WEEKLY CG		-	2.56	-	2.50	-	-	-	-	-	7.24	-	
	WEEKLY SS		-	2.50	-	4.12	-	-	-	-	-	6.92	-	
Cox (1955)		-	-	-	-	-	-	-	-	-	-	-	-	Study of masking sound pressure levels in audiometric testing rooms.States that earphone fit may result in variations of ± 5dB throughout the frequency range.
Burns and High-Cliffe (1957)	MANUAL	-	-	-	24.01	17.14	-	22.09	22.09	22.09	57.76	-	-	Subjects: 20 medical students and university teachers aged 20 to 48 years, all otologically normal and audiometrically naive. A comparison of manual and automatic testing methods.
	AUTOMATIC	-	-	-	40.96	27.04	-	14.44	38.44	40.96	108.16	-	-	

	80	125	250	500	1000	1500	2000	3000	4000	6000	8000	12000	
Corso and Cohen (1958)	RIGHT EAR												Subjects: 18 male, 20 female, first year psychology undergraduates. Methodological study of auditory threshold measurement. Authors used manual audiometry.
	-	-	7.08	6.15	4.58	3.96	3.80	5.34	7.02	12.18	15.05	-	
	LEFT EAR												
	-	-	10.18	11.80	5.76	7.24	13.91	24.50	25.81	38.32	42.38	-	
O'Connell and Hamlyn (1959)	LEFT EAR												Subjects: 42 U.S.A.F. airmen aged 17 to 24 years. Nine audiograms were taken as an extension of normal pre-placement audiometric testing in order to examine intra-subject variability. Automatic Audiometry.
	-	-	-	23.72	6.20	-	7.62	10.56	23.14	76.91	-	-	
	RIGHT EAR												
	-	-	-	39.94	22.09	-	26.73	34.69	47.75	81.54	-	-	
Kylin (1960)	-	20.25	10.24	4.00	4.00	5.29	5.29	6.25	9.61	12.25	18.49	30.25	Subjects: 10 otologically normal. Ages 20 to 27 years (mean 23 yrs) Investigation of magnitude of intra-subject variability. 10 audiograms taken from each subject. Concluded that for a threshold change to be significant at the .05 level it must be at least 5.0 dB in the middle frequencies and 7.5 dB at lower and higher frequencies, to the nearest 2.5 dB step above. Manual Audiometry.
Robinson (1960)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects: Unspecified number of normal listeners. Investigation of intra-subject variability compared findings with those of Brown (1948) and concluded that the comparison was very close. Manual Audiometry.

	80	125	250	500	1000	1500	2000	3000	4000	6000	8000	12000	
High and Glorig (1962)	LEFT EAR												Subjects: 63 men and 16 women workers not exposed to "excessive industrial noise".Two-thirds were factory workers, the rest office workers.Study of intra-subject variability.Automatic Audiometry.
	-	-	-	18.84	18.92	-	18.84	17.89	17.81	29.39	-	-	
	RIGHT EAR												
	-	-	-	15.68	25.20	-	13.32	17.14	19.80	26.01	-	-	
Jackson Fassett Riley and Sutton (1962)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects: 4 experienced subjects in one study, 30 naive in another. All were factory workers.Results expressed as differences between hearing levels and analyses of variance. Found significant between tests and between audiometers variance.Also found a learning effect.Manual Audiometry.
Atherley and Dingwall-Fordyce (1963)	-	-	-	8.5	7.5	-	7.0	6.0	17.0	19.5	23.0	-	Subjects: 12 otologically-normal male medical students. Manual Audiometry.
Rudmose (1963)	AVERAGE S.D.'s, LEFT EAR												Subjects: 7 men with several years experience of industrial serial audiometric testing.Study of intra-subject variability. 7 to 10 audiograms taken from each subject. Automatic Audiometry.
	-	-	-	14.46	12.25	-	15.21	19.36	16.00	17.64	-	-	
	RIGHT EAR												
	-	-	-	19.36	9.61	-	12.25	19.36	10.24	16.81	-	-	
	GROUP S.D.'s, LEFT EAR												
	-	-	-	13.69	10.88	-	14.46	22.09	16.00	18.49	-	-	
	RIGHT EAR												
	-	-	-	16.81	10.24	-	12.96	18.49	13.69	24.01	-	-	
Rodda (1965)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects: 5 young girls and 4 young boys,all with suspected hearing losses.Results expressed in terms of hearing levels and analysis of variance.Found significant inter-operator differences.Both manual and automatic Audiometry.

	80	125	250	500	1000	1500	2000	3000	4000	6000	8000	12000	
Hickling (1966)	2 MINUTES												Subjects: 60. Study of intra-subject variability as a function of time between tests, 2 minutes, 2 hours, 24 hours. Manual Audiometry.
	-	-	-	-	5.15	-	4.97	-	-	12.32	11.56	-	
	2 HOURS												
	-	-	-	-	6.15	-	7.02	-	-	20.07	16.65	-	
	24 HOURS												
	-	-	-	-	10.96	-	10.96	-	-	27.46	24.50	-	
Delany Whittle Cook and Scott (1967	-	-	-	-	-	-	-	-	-	-	-	-	Subjects: 25. Study of the calibration of an artificial ear. Found that 2 or 3 of their subjects gave unreliable indications of auditory threshold and were consistently discarded.
Delany (1970)	LEFT EAR												Subjects: 4 otologically normal, normal hearing males.Study of learning effect.Selection,given by Delany, of replication varience over 27 months, component due to true long-term changes was said to be 1-2 (dB)^2 .Automatic Audiometry.
	–	–	–	6.0	3.0	-	3.5	6.5	10.0	20.0	-	-	
	RIGHT EAR												
	-	-	-	10.0	6.0	-	6.0	9.0	8.0	21.0	-	-	
	BOTH EARS												
	15.0	-	-	-	-	-	-	-	-	-	-	30.0	
Robinson and Burdon (1970)	-	-	-	-	7.6----------	- ----------	9.6	9.5---------	--------	22.1	-	-	Four groups of subjects with varying levels of exposure to industrial noise. Results expressed as maximum and minima of the replication variance obtained from the four groups averaged over 1000 and 2000 Hertz and 3000, 4000 and 6000 Hertz.Manual Audiometry.
Delany (1971)	-	-	-	-	-	-	-	-	-	-	-	-	Reported unpublished work by J.J. Knight which showed improvements in mean hearing level still continuing after 10 tests.

	80	125	250	500	1000	1500	2000	3000	4000	6000	8000	12000	
Gosztonyi, Vassallo, and Sataloff (1971)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects:Randomly selected heavy industry employees,50 hourly-paid 50 salaried.Investigated subject, operator,and audiometric technique variability.Expressed results as hearing level differences. Found often considerable differences.Both Manual and Automatic Audiometry.
Stephens (1971)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects:Expressed results as mean improvements in hearing-levels. Found the learning effect differed between introverts and extraverts. Automatic Audiometry.
Howell and Hartley (1972)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects:143 new entrants to 2 factories.Expressed results in terms of hearing differences obtained by 2 different operators on the same subjects.Found great inter operator variability.Manual Audiometry.
Hartley Howell Sinclair and Slattery (1973)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects:132 apprentices at each of 2 firms, 45 noise results expressed as differences in hearing levels between successive tests.Found 3 audiograms taken at one session to be as good as 3 at separate sessions Found operator variability to exceed subject variability at 3000 and 4000Hertz.Manual Audiometry.

	80	125	250	500	1000	1500	2000	3000	4000	6000	8000	12000	
Robinson Shipton and Whittle (1973)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects:147 workers from various occupations.Expressed results in terms of hearing-levels.Discovered a large learning effect.Found some subjects to be inconsistent from the outset, others not. Automatic Audiometry.
Robinson and Whittle (1973)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects: 48 paid volunteers from general public.Investigated differences between audiograms obtained by manual and automatic methods.Results expressed in terms of hearing-levels.Found learning effect to be a confounding variable.
Pelmear and Hughes (1974)	-	-	-	-	-	-	9.0	-	-	36.0	-	-	Subjects:118 Drop-forgers.Variances given by the authors are the extremes found.Automatic Audiometry
Robinson Shipton and Whittle (1975)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects:223 workers from both noisy and non-noisy occupations divided into two groups.One group provided 3 audiograms at 3 separate sessions.The other provided 3 audiograms at the same session. Expressed results in terms of hearing levels.Concluded that one extended test session is preferable to a succession of shorter tests in terms of error reduction.Automatic Audiometry.
Thomas Royster and Scott (1975)	-	-	-	-	-	-	-	-	-	-	-	-	Subjects:In one study 118 employees in a second study 400 employees. Found a significant difference between first and second ear tested, the first ear being the poorer. Results expressed in terms of hearing levels. Automatic Audiometry.

2.5 Implications of the Evidence for the Uses of Industrial Audiometry

It is apparent that the overwhelming majority of the experimental evidence concerns technical parameters of audiometry, in particular the accuracy and reliability or repeatability of audiometric measurements. The question is, how does this relate to that which is expected of audiometry performed in industry. In other words, what objectives is audiometry perceived as fulfilling. Once these have been identified, it will be clear why the particular kind of experimental evidence that exists was sought out at all. This is essentially a process of working backwards from effect to cause.

Audiometry, in common with all other measurements of human characteristics, can be used to make statements about individuals separately or about individuals aggregated into groups. Different implications flow from consideration of the two uses. Let us consider audiometric statements about individuals first.

An audiogram obtained from an individual is a record of that individual's hearing acuity at the time of the audiometric test and a series of audiograms obtained over a long period of time provides a record of the rate of deterioration of the individual's hearing acuity, assuming that there is a deterioration. It is obvious that the truth of the last sentence depends heavily upon audiometry's being extremely reliable, hence the need for the evidence that has been reviewed. Nevertheless, if we assume that this is what audiometry does, then audiometry can be used

It can be used to establish

an initial record of an individual's hearing acuity so that extra information is available to help in decisions about the individual's employment with or placement within a company. As a general rule, this will be done with new entrants to a company and so the designations pre-employment audiometry and pre-placement audiometry are appropriate. Alternatively, the reason for such pre-employment or pre-placement audiometry can be to establish a baseline audiogram against which to compare later audiograms. This use of audiometry, pre-employment audiometry, and pre-placement audiometry will be subsumed under the general heading "Pre-employment Baseline Audiometry" since the three uses will usually occur together. It can be seen that since major decisions may be taken on the basis of such a baseline audiogram, accuracy is particularly important. Hence the experimental concern with producing the best baseline audiograms for the least time and effort.

An audiogram may also be used during the course of an individual's employment to discover whether or not the individual has an abnormality of hearing which requires further attention or a decision concerning his or her job-location. This is the use of audiometry as a screening test for hearing disorder. This is similar to Pre-employment Baseline Audiometry except that it can be done at any time during the course of an individual's employment with a company as part of a programme of continuous monitoring of employees' hearing acuity, but it differs from Pre-employment Baseline Audiometry generally in that an individual who screens positively may be sent for further testing. Thus, it is acceptable to save time and effort at the expense of a certain degree of accuracy. This is a second use - heading for audiometry - "Case-finding Audiometry". If an individual is screened out for further attention, then this further attention may involve referral to a National Health Service Ear, Nose and Throat (E.N.T.) department for more extensive tests to be performed. It is possible that a greater degree of efficiency may be attainable if the more exhaustive testing is done at the company itself by means of extensions to the equipment and expertise of the medical department. As such an extension of industrial audiometry is essentially diagnostic in character, it will be placed under the heading "Diagnostic Audiometry".

It was mentioned in an earlier paragraph that an audiogram may be taken as part of a continuing programme of audiometric testing. One of the functions of such a programme is to detect changes in an individual's hearing level, so that further action may be taken. In this sense, the points made in connection with screening audiometry apply here also. However, this use of audiometry brings us to consideration of the ability of audiometry to make statements about groups of individuals because, just as an individual's hearing acuity can be followed over time, so can the average hearing acuity of the group to which the individual belongs. A company may wish to do this as a means of assessing overall its wider ongoing programme of hearing conservation measures. The studies of Gosztonyi et al. (1971) and Robinson et al. (1973) reported earlier imply that errors in audiometry may not be random but if it is assumed that they are (as the studies of Brown (1948) and Waldron (1959) suggest) and if due allowance is made for aging and personnel turnover in the group in question, then audiometry can be used for this purpose with little heed being paid to the unreliabilities inherent in audiometric testing. The monitoring both of individuals and of groups will be called "Group-monitoring Audiometry".

If audiometry is carried out for the purpose of helping to maximise the performance of a hearing conservation programme, then, if a part of this programme concerns maintaining amongst workers an awareness of the reality of occupational deafness and their own part in helping to prevent it, audiometric testing sessions may provide an opportunity for influencing workers individually on this point. Such an objective of a programme of audiometric testing will be placed under the heading of "Educative Audiometry" for want of a better term. This may appear to be very much a secondary objective of audiometry and indeed no evidence exists of audiometry's ability to perform such a function. Nonetheless, it has been proposed by several people and so will be discussed further later. Note that the evidence reviewed is not directly relevant to this proposed function.

So far the evidence concerning industrial audiometry has been reviewed and five possible headings under which to place the objectives of industrial audiometry have been deduced. In some senses they could all be discussed under the general heading of Monitoring or Routine Audiometry since they could all be considered routine or part of a programme of monitoring something or other. This would be a discussion of audiometry on a basically procedural level. On a functional level, it is possible to view Case-finding Audiometry, Pre-employment Baseline Audiometry, Group Monitoring Audiometry and, possible, Diagnostic Audiometry under the general heading of Screening Audiometry. Case-finding Audiometry is the screening out of individuals who require treatment or special consideration of some sort (such as job re-location) or further testing. Group Monitoring Audiometry is the screening of an industrial population for the existence of progressive noise-induced hearing-loss after hearing conservation measures have already been taken. Pre-employment Baseline Audiometry is partly case-finding and partly the establishment of an accurate criterion against which to evaluate later tests if changes in hearing level are being screened for. Diagnostic Audiometry in an industrial setting may be considered as screening if the screening criteria separate hearing disorders into those treatable by the company health service and those treatable only by a specialist outside E.N.T. unit. However, the inclusion of Diagnostic Audiometry under the general heading of Screening Audiometry is probably based upon more tenuous grounds than the first three functions.

The importance of considering industrial audiometry as a screening device will become apparent later. So for the purpose of discussing the written opinion concerning the usefulness of industrial audiometry, all five headings will be used with the first four being discussed as categories of Screening Audiometry.

To reiterate, the headings are, in the order of discussion:-

<u>Screening Audiometry</u>

(a) Pre-employment Baseline Audiometry
(b) Case-finding Audiometry
(c) Group monitoring Audiometry
(d) Diagnostic Audiometry

2.6 Screening Audiometry

2.6.1 The Validation of Medical Screening Procedures

Before audiometry is discussed as a screening test, it is necessary to comment upon the validation of medical screening procedures in general, an issue succinctly summarised by McKeown (1968). McKeown outlines two basic types of criteria which should be met before a screening procedure is accepted for use. These two types he calls, biological and economic. The aim of screening, in the words of McKeown, is "early identification of treatable disease, preferably in the presymptomatic stage". The biological criteria include knowledge of the natural history of the abnormality, the ability to identify it at an early stage by screening, and to have methods of treatment or care which will benefit those afflicted. The economic criteria are a reflection of the recognition that financial resources are limited and so any screening procedure must justify itself in terms of costs relative to competing demands upon the limited resources available. A vital contributor to costs is the ability of the screening test to identify the abnormality in question and the reliability of the test in so doing. Reliability is particularly important as this will affect the number of tested individuals who are wrongly classified. There are two types of such incorrect classifications, false positives and false negatives, the former being testees who are identified as having the abnormality when in reality they do not, while the latter are individuals identified as being clear of the abnormality when in fact they are not. Besides representing a strain upon financial resources, such wrong classifications have a human cost since each false positive represents an individual needlessly worried while each false negative is an individual dangerously reassured. This is a particularly important point when one considers that people are either screened upon the initiative of some authority for a condition when they do not show symptoms or that, on their own initiative, they request to be screened upon the implicit assumptions; (a) that if they have the condition, the screening test will demonstrate it and vice versa, and (b) that some effective treatment is available. In addition, authorities are unanimous that it would be unethical to screen if no treatment were available. It is against this background of medical screening test validation that the evidence and opinions concerning screening audiometry should be viewed.

2.6.2 Industrial Audiometry as a Medical Screening Procedure: General Considerations

With specific regard to screening audiometry the implications of the test are largely a function of what is being screened for and the remedies used. If hearing abnormality is being screened for, then the remedy usually involves referral to a N.H.S. E.N.T. Department for diagnosis and treatment. As intimated above, this costs time, money and manpower. It may also worry the families and friends of individuals who screen positively. Thus, if a positive screen is false, all this cost is wasted and needless. The possibility of a backlash of anger and, more importantly, resentment exists. On the other hand, if a negative screen is false, there is a the danger of needless suffering for the individual and greater expense of time, money and manpower later (again with the possibility of anger and resentment). If hearing deter-

for, then a positive screen may,

in some companies, result in the individual being removed to a quieter job or, in some companies, result in personal hearing protectors being prescribed for the individual concerned (in this case, the individual may be exhorted most strongly to wear them for all of the time necessary). As before, a positive screen will involve time, money and manpower (though not to the same extent) but, more importantly, the remedy may involve hardship to the individual in terms of money, comfort and so on. A question that must be answered then is, how acceptable is the remedy to the individuals who must bear it? If the remedy is not acceptable, it will not be adhered to and so there is no point in screening at all. The effects of false positives and false negatives are as outlined above with the exception that a backlash of anger and resentment could be expected to be proportional in vehemence to the degree of unacceptability of the remedy. (An interesting question here is, why should a company use audiometry to screen out individuals with deteriorating hearing for prescription of personal hearing protectors instead of dispensing with audiometry and simply issuing person hearing protectors to every noise-exposed employee? Could it be that it is considered more rational and economic, or could it be that personal hearing protectors are known to be generally unpopular so that screening audiometry reduces the population it is necessary to use persuasion upon as well as backing up such persuasion with medical authority?)

It is the case that the implications of a programme of screening audiometry are likely to be affected by the screening criterion used. However, the literature gives no indication of the universal use of any particular criterion or criteria for different screening purposes. It seems reasonable to assume, therefore, that different industrial medical officers use different screening criteria. This will make the cost, financial or otherwise, of programmes of audiometric screening very variable.

2.6.3 A Dilemma for Industrial Medical Officers

In the section dealing with Pre-employment Baseline Audiometry, certain medico-legal considerations were discussed. (A review of medico-legal aspects of audiometry has been made by Coles and Martin (1973)). If the general context of screening is considered, then it is possible to envisage an employer wanting to screen out those individuals likely to sustain a hearing-loss compensable at common law. This brings the litigation aspect of Pre-employment Baseline Audiometry more fully into the screen rubric as well as being analogous to the case of noise-susceptibility. But while on the one hand this is largely a matter outside of scientific inquiry, being instead a matter for the courts and legislation (should the issue enter the realm of statute law), on the other hand it highlights the problem of dual loyalties which must occur in industrial medical departments. Atherley and Hale (1975) discussed this point with particular reference to health and safety specialists, but of the industrial medical officer, they have this to say:

> "The industrial doctor is perhaps in the clearest position with the tradition of doctor-patient relationship and its confidentiality behind him; but even he can be placed in a situation where the interests of an individual patient to whom he owes his loyalty, and of the firm who pays him, conflict."

Obviously there must be a loyalty to the patients, for whose care and protection the medical department exists, and a loyalty to the employer, who provides and maintains the medical department and so there is no reason why Screening Audiometry cannot be done for both medical and economic reasons. This duality of loyalties, though, may be an important factor in the decision-making processes of occupational health within a company far beyond just industrial audiometry.

2.6.4 Pre-employment Baseline Audiometry

A much more important objective which it was suggested earlier that audiometry may fulfil is that of laying a baseline against which later comparisons may be made. It has been suggested that such a baseline may also be used in deciding where to employ people or whether to employ them at all, if taken as part of a pre-employment medical examination. It is obvious that if ever accuracy were required in industrial audiometry, it is where a baseline is being established. With case-finding audiometry accuracy can, to some extent, be sacrificed for speed as errors can be rectified later (except, probably, in the case of false negatives as was mentioned earlier). This may be an economic and administrative drawback, but it can nevertheless be done. With a Case-finding Audiometry programme, the unreliability and uncertainties present force one to look for trends over several separate examinations rather than allowing one to rely upon a single audiogram for confirmation of one's suspicions. But when one is establishing a baseline to be used as a reference for later audiometry, then it is vital to get it right first time. If a baseline audiogram is being used as part of the procedure for deciding a man's job prospects for him then the man has a right to expect the baseline established to be as correct as possible. (This, of course, assumes that the philosophy of pre-employment medical examinations is acceptable). Thus, the reliability studies discussed earlier have relevance here.

Each of the two main reasons for this function of audiometry, pre-employment (and pre-placement), and establishing a reference for later comparisons, can be further divided into two. Pre-employment baseline audiometry may be used to assess an individual's fitness to do the job in question (see Table 2) or it may be used to assess the degree of risk that an individual's hearing level poses to the safety of himself and others (see Table 3). The first point involves the whole area of medical screening once more. It is interesting to note, however, that the International Civil Aviation Organisation, while still accepting the screening of flight deck staff for hearing disability, recommend that audiometry is not necessary for this purpose. The second point is based on the argument that an individual with poor hearing may fail to hear warning signals or the approach of others and so therefore would be a liability to the safety of all, himself included. This may well be so, but it is often forgotten that hearing protectors are provided for use in noisy conditions and that these, while usually facilitating speech perception in noisy conditions, also adversely affect the perception of direction from which sounds are coming (Atherley and Noble (1970a). Atherley and Else (1971)), once more a problem for safety. There appears to be a paradox here.

2.6.4.1 Audiometry as a company defence against possible employee-initiated litigation

Pre-employment Baseline Audiometry used to establish a reference point for later comparisons can also serve two functions: it can be the start of a programme of serial Case-finding Audiometry (see Table 4), or it can provide a record of employees' start-of-employment hearing levels for use in possible litigation initiated by employees for alleged noise-induced hearing loss (see Table 5). Group-monitoring audiometry will be dealt with in detail in another place, but Pre-employment Baseline Audiometry for legal purposes is a highly emotive subject with few facts to act as guidelines. Two separate issues emerge from this area. One is, should medical services really be used for such purposes? This refers back to the split loyalties experienced by industrial medical staffs and referred to earlier and concerns the problem of whether or not medical staffs should carry out procedures designed to benefit the organisation for which they work rather than the employee in their care. Pelmear and Hughes (1974) make the following statement, "The employer, while wishing the results to be useful for this purpose ("health counselling") to conserve the hearing of employees, will also desire reliable recordings to refute subsequent litigation claims." A different view is expressed by Trevithick (1973):

> "There is always a dichotomy of view with regard to building up evidence to protect the employer against Common Law claims. Many doctors would hold that any recommendations which they make are designed to protect the employee, and that attempts to provide Common Law coverage militate against the success of the programme."

This is basically an issue of ethics and should be resolved ... otherwise there is a grave risk of compensation-oriented audiometry being performed and then rationalised away in some manner or other as being of indispensable benefit to the employee.

The second issue is, can audiometry succeed in protecting an employer from litigation claims? References have been quoted which say yes, but it appears obvious that audiometry could be just as successful in supporting the employee in a Common Law case as the employer. This point appears to have been overlooked in the literature. Also, in the United Kingdom at least, the legal position of audiometry has not been established and is equivocal at best. Several Common Law claims have been successful. These include, Berry v Stone Manganese Marine Ltd 1971 in which a ratio decidendi precedent was set unfavourable to routine industrial audiometry, and Bolton v Hawker Siddeley Aviation Co. 1973 in which an obiter dictum precedent was set favourable towards audiometry. Depending upon the hierarchical relationship between the courts concerned, an obiter dictum precedent is generally of lower standing than a ratio decidendi precedent, but whatever the case in this instance, the equivocal position of audiometry in English Common Law is demonstrated. However, the United States of America, audiometry, of the baseline and serial varieties, is firmly entrenched in statute law (Federal Occupational Safety and Health Act 1970) and has been used in litigation for many years. When different State practices are taken into account as well, we have a veritable attorney's dream of masses of confusing hearing loss litigations going before the courts and Workmen's Compensation Boards. Whether this would ever happen in the United Kingdom or not is a matter for conjecture.

A relevant point in the event of such an eventuality is the comparison made earlier between the studies of Gosztonyi et al. (1971) and Robinson et al. (1973). The former discovered a much higher incidence of unreliability than any of the other studies reviewed and also discovered that hourly-paid workers were extremely unreliable in their audiograms, unlike the findings of Robinson et al. Gosztonyi et al. attributed this unreliability to "malingering" which, of course, is more likely in an intense atmosphere of possible litigation arising from audiometry. Could it be that if audiometry were to be used extensively in the U.K. for compensation purposes, that the reliability of the technique would be further undermined, thus necessitating even more extensive procedural safeguards?

2.6.4.2 Economic and administrative considerations

This brings us neatly to the last question, namely, is Pre-employment Baseline Audiometry worth the time, the effort or the money? There is a dearth of studies on the costs of audiometry and those which have been done tend to conflict, possibly because different assumptions were used. There are several organisations which will perform audiometry in the U.K. on a contract basis and which charge, at the time of writing, of the order of £3.00 per audiogram. But it should be noted that none of these figures include the cost of lost production and wages involved when an employee is sent for an audiometric examination. If it is recognised that Pre-employment Baseline Audiometry may require the taking of at least two audiograms then it can be seen that costs may escalate rapidly. This point has been made by several writers (Hartley and Sinclair (1973), Howell

(1973), Trevithick (1973)) who also point out the daunting nature of the administrative time and effort involved in all routine audiometry.

Whether or not Pre-employment Baseline Audiometry is worth all this trouble is a matter to be decided in the light of the points already made in this section, but it is obvious that there is a need for cost-effectiveness and cost-benefit studies, using generally accepted parameters before such a decision can be made.

TABLE 2 Audiometry as a Means of Assessing the Job Fitness of New Entrants

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
C.H.A.B.A. 1955	
Hirsch 1957	
Sataloff 1957 (by implication)	
Davis et al. 1958	
Lawrence 1963	
Kryter 1965	
Bell 1966	
Sataloff et al. 1966	
World Health Organisation 1966	
Watson 1967	
Fox 1969 (by implication)	
Bearce et al. 1970	
Fox 1970	
Robinson 1970	
Sataloff 1970	
van der Sandt 1970	

TABLE 3 Audiometry as a Means of Evaluating the Degree of Safety Risk Arising from Hard-of-Hearing New Entrants both to Themselves and to Others

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
Davis et al. 1958	
Shone 1958	
Fox 1969 (by implication)	

TABLE 4

Audiometry as a Means of Establishing a Baseline for a Programme of Routine Monitoring of Workers' Hearing Levels for Case-Finding Purposes

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
Barron and Love 1955	
Sataloff 1957	
Davis et al. 1958	
Lovejoy 1958	
Shone 1958	
Dickson 1961	
Katz et al. 1963	
S. Australia Department of Public Health 1965	
Bell 1966	
Sataloff et al. 1966	
Hipskind 1967	
Walworth 1967	
Olishifski 1968	
Broker 1969	
Delk and Lowe 1969	
Fox 1969	
Walworth 1969	
Watson 1969	
Wyman 1969	
Bearce et al. 1970	
Fox 1970	
Istre et al. 1970	
Sataloff 1970	
Pelmear 1973	
Stone 1974	

TABLE 5 Audiometry as a Means of Establishing a Baseline for Possible Litigation Purposes

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
Barron and Love 1955	Gregory 1973 (by implication)
C.H.A.B.A. 1955	
Hirsch 1957	
Sataloff 1957	
Lovejoy 1958	
Dickson 1961	
Summar 1965	
Bell 1966	
Sataloff et al. 1966	
World Health Organisation 1966	
Hipskind 1967	
Walworth 1967	
Broker 1969	
Murphy 1969	
Walworth 1969	
Wyman 1969	
Hamilton 1970	
Robinson 1970	
Van Der Sandt 1970	
Surbock 1971	
Grested 1972	
Pelmear 1973	
Sataloff et al. 1973	
Sataloff and Michael 1973 (by implication)	
Pelmear and Hughes 1974	
Stone 1974	

2.6.5 Case-finding Audiometry

Case-finding Audiometry is the detection, via a regular programme of routine or serial testing, of individuals whose hearing has deteriorated sufficiently to require special consideration or further testing. Also it is the detection of so-called noise-susceptible individuals - individuals whose hearing deteriorates particularly rapidly in the presence of noise or whose hearing is damaged by relatively low levels of noise. There appears to be no generally agreed definition of noise-susceptibility in the literature and, indeed, no satisfactory test of susceptibility to noise has yet been discovered (Burns and Robinson 1970). Thus only case-finding audiometry can be used for this purpose which begs the question of the screening criterion to be used.

It is apparent that if audiometry is to be used in a case-finding role then it must be reasonably reliable, though not, perhaps, to the extent required by Pre-employment Baseline Audiometry. From the reliability studies discussed earlier, this proviso would not appear to be the case. Some of these studies suggested that most of the unreliability present in audiometry may be due to a small number of inconsistent individuals, the rest being consistent, but what if an inconsistent individual were also a noise-susceptible one, however that may be defined? Also Robinson and Burdon (1970) found that unreliability increases with length of exposure to industrial noise so it may be the case that an individual with increasing noise-induced hearing-loss may be producing progressively more untrustworthy audiograms as his or her hearing-loss becomes more critical. In addition, the criticality of a hearing-loss is linked to social disability yet Noble (1973) (discussed earlier) has found evidence questioning the validity of audiometry as a measure of social disability.

Thus, the ability of industrial audiometry to perform a case-finding role may be seriously doubted. Nonetheless the body of opinion in favour of this function of industrial audiometry greatly outweighs that against it (see Table 6). Also while some authors suggest that audiometry may be too slow to detect real changes before they become detectable by other means (by which time the damage is done) (Hartley 1972, Atherley et al. 1973) many more are confident of audiometry's ability to detect noise-susceptible individuals (see Table 7).

TABLE 6 Audiometry as a Means of Identifying Individuals Requiring "Treatment", Special Consideration or Further Testing

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
Sataloff 1957	Atherley et al. 1973
Waldron 1959	
Dickson (1961 (by implication)	
Lawrence 1963 (by implication)	
Witwer et al. 1963	
Bell 1966	
Watson 1967	
Murphy 1969	
Watson 1969	
Wyman 1969	
Bearce et al. 1970	
Istre et al. 1970	
Harford 1971	
Pilz 1971	
Grested 1972	
Pell 1972	
Pell 1973	
Sataloff et al. 1973	
Grover 1974	
Stone 1974	
Thomas et al. 1975	

TABLE 7 Audiometry as a Means of Detecting Noise-susceptible Individuals

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
Sataloff 1957	Howell and Hartley 1972
Davis et al. 1958	Atherley et al. 1973
Shone 1958	
Dickson 1961	
Boenninghaus and Roser 1962	
Juselius 1962	
Hickish 1963	
Burns et al. 1964 (by implication)	
Bragg 1965	
Bell 1966	
World Health Organisation 1966	
Watson 1969	
Robinson 1970	
Sataloff 1970 (by implication)	
Adam 1971	
Somerville 1976	

2.6.6 Group Monitoring Audiometry

The weight of the evidence so far reviewed supports the conclusion that group means can be reasonably reliable (but not necessarily so, as in Gosztonyi et al. (1971), but individual variability can be so great as to make differences in an individual's repeat audiograms suspect unless they are either considerable or sustained over several audiograms. This implies that routine audiometry can be used, (a) to evaluate the effectiveness of a hearing conservation programme, (b) to evaluate the efficiency of hearing protectors that have been provided, and (c) to evaluate the degree of risk to workers who refuse to wear hearing protectors when provided. Indeed, these suggested uses are each supported by a large body of printed opinion as opposed to a relatively small body expressing a contrary viewpoint (see Tables 8, 9 and 10).

TABLE 8 Audiometry as a Means of Evaluating the Effectiveness of a Hearing Conservation Programme

Authors Expressing Opinions In Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
Waldron 1959	Gregory 1973 (by implication)
Hickish 1963	Howell 1973
Katz et al. 1963	
Witwer et al. 1963	
Heffler 1965	
Keys 1965	
Bell 1966	
World Health Organisation 1966	
Watson 1967	
Delk and Lowe 1969	
Hermann 1969	
U.S. O.S.H.A. 1970	
Robinson 1970	
Sataloff 1970	
Harford 1972	
Pell 1972	
S. Australia Department of Public Health 1972	
Arlinger 1973	
Coles 1973	
Pell 1973	
Pelmear 1973	
Sataloff et al. 1973	
Trevithick 1973	
Stone 1974	

TABLE 9 Audiometry as a Means of Evaluating the Efficiency of Hearing Protectors

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
Keys 1965	Gregory 1973
Bell 1966	Hartley and Sinclair 1973
World Health Organisation 1966	
Pell 1972	
Arlinger 1973	
Pell 1973	
Pelmear 1973	
Franzen and Stein 1974	

TABLE 10 Audiometry as a Means of Evaluating the Degree of Safety Risk Arising from Hard-of-Hearing Workers both to Themselves and to Others by a Refusal to Wear Hearing Protectors Provided

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
Heffler 1965	
Keys 1965	
Burns and Robinson 1973	
Somerville 1976	

2.6.6.1 Evaluation of Hearing Conservation Programmes and Hearing Protector Efficiency

So far, literature concerning the usefulness of audiometry in monitoring a hearing conservation programme and in assessing the efficiency of hearing protectors without defining these terms has been looked at. This is because such a definition does not appear in the literature reviewed. Yet this is vital to any research on the subject, and even more so to the way in which audiometry is likely to be used in industry. With regard to a hearing conservation programme a definition can be couched either in terms of group means or in terms of individual audiograms. This is empirically pertinent too, as the evidence reviewed shows. Thus, a hearing conservation programme might be considered to be working if the group mean hearing level deteriorates by no more than X dB over Y units of time or alternatively it may be adjudged to be working if no more than x% of the population in question each suffer a deterioration in hearing level of Y dB or more over Z units of time allowing for presbycusis and so on. This is an important point as a hearing conservation programme may prove itself by one definition yet fail by the other. The definition to be chosen will depend upon the goals of the hearing conservation programme. A definition in terms of group means is, at first sight, simpler in practical terms but in reality this simplicity is spurious owing to labour turnover rates and other factors liable to affect the composition of the workforce. A definition in terms of individuals, though, is more appropriate from the medical officer's point of view as it is his business to protect each individual in the population that he is responsible for even though this is more difficult administratively.

So the two types of definition can be interpreted as representing the industrial medical officer's dilemma in microcosm, that is, does he do what he is trained to do, and see his "patients" as being his first responsibility, or does he do what seems to be most suitable to his employers, in this case run the ostensibly simpler of the two types of hearing conservation programme? (The medical officer's dilemma will be referred to again later). This duality of possible definitions has implications for the type of research needed to investigate the claim that audiometry is useful in monitoring the effectiveness of a hearing conservation programme. This will be further discussed later.

In similar fashion, the efficiency of hearing protectors needs to be examined. It is a subsidiary of the problem of the effectiveness of a hearing conservation programme, which is why it is being considered along-side it and why it will be treated as part of that general problem for the remainder of this thesis, but is does present its own interesting problems. In the technical sense, it can be defined in terms of the attenuation of the hearing protectors in question. This can be ascertained without the hearing protectors making contact with a human being. However, for technical reasons, the validity of such measurements is in some doubt when hearing protectors are actually worn. Therefore, it is argued, periodic testing is necessary in order to see if hearing protectors are indeed preventing hearing loss as we are not certain, in the present state of knowledge, of how much protection they can be expected to give (even making the dubious assumption that they are worn for 100% of the time necessary). This is where this problem becomes part of the problem of hearing conservation programme efficiency. So once again, the same problems of definition arise as before. But there are other more specific ones. For example, hearing protectors may protect hearing, but at what cost to other safety factors such as ability to hear warning shouts or directional hearing (Else 1976b) Does the definition of efficiency distinguish between sound frequencies central to the perception of speech and those not so central? Does the definition make any assumptions about the correctness of hearing protector use (i.e. time worn, proper wearing, and so on)? (Else (1976b)has dealt with this matter in detail). All these points are important in any discussion of the efficiency of hearing protectors and so any investigation of the matter must start either with its own definition or a pilot study to find out what definitions are actually in use, albeit implicitly.

2.6.7. Diagnostic Audiometry

This title does not refer in any way to Clinical Audiology or to any of the procedures associated with it, but to the use of pure-tone audiometry for diagnostic purposes in industry itself. Such a use of audiometry would necessarily require that in addition to determining air-conduction hearing thresholds, facilities should at least be available for the determination of bone-conduction hearing thresholds. Full-scale otological diagnosis is a lengthy process, too lengthy to be contemplated in an industrial context, and so what appears to be the aim of diagnostic audiometry in an industrial setting is to provide an aid to the early diagnosis of otological disorders so that decisions can be made as to the disposition of afflicted workers. Part of the motivation for championing diagnostic audiometry in industry appears to be the laudable desire to take the strain away from already over-worked E.N.T. Departments in local hospitals. Support for industrially based diagnostic audiometry, for one reason or another, has been voiced by a number of writers (see Table 11).

For example Sürbock (1971) has reported that the Occupational Branch of the Austrian Health Service has been employing audiometry in this kind of preliminary diagnostic role since 1962. However, an opposing viewpoint has been epxressed by Bell (1966) in a paper on noise and deafness commissioned by the World Health Organisation (included in Table 10).

There are several points to be made here. The use of audiometry for diagnostic purposes in industry is not a matter open to scientific exploration, but instead must be decided upon practical and economic grounds. As regards the practical aspects, diagnostic audiometry of the sort described is of little use as afflicted workers will still need to be referred to their local E.N.T. Department for examination anyway, thus negating one suggested benefit. Indeed, taken in conjunction with case-finding audiometry, dealt with earlier, there is a possibility of even more referrals being made to already overworked E.N.T. Departments. There is no evidence or literature concerning this point as yet, but personal communications (Bland, 1975) indicate that this may already be occurring in the U.K. at least. This highlights a need for research to investigate the possibility that unwelcome stresses may be forming which can only be to the detriment of all concerned - company medical departments, hospital service, and patient - and even some of those not concerned, namely, non-industrial patients in need of otological care. Regarding the economic aspects, it may not be economically worthwhile for a company to provide a service which is, and probably would still have to be, provided by the local hospital services. The Austrian experience is not applicable to this argument as the Austrians provide a national occupational health service which is not the responsibility of individual companies and which has closer organisational links with the State health service. Finally, these considerations apply also to the case of making arrangements for otologically abnormal individuals.

This possible objective of industrial audiometry is perhaps the least stressed of all by those who favour audiometry in industry. It is possible that many companies in the U.K. perform audiometry for diagnostic purposes at present. Ensell (1973) reported that the British Aircraft Corporation Medical Service at Bristol performed bone-conduction audiometry in certain circumstances and there are probably other companies which do so too. The use of audiometry in industry for diagnostic purposes would thus appear to be a matter outside the mainstream of the controversy surrounding industrial audiometry.

TABLE 11 Audiometry as part of a Company Health Service's Diagnostic Armamentarium

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this purpose
C.H.A.B.A. 1955	Bell 1966
Hirsch 1957	Bland 1975
Davis et al. 1958	
Lovejoy 1958	
Juselius 1962	
Istre et al. 1970	
Sataloff 1970	
Harford 1971	
Sürbock 1971	
Pell 1972	
Ensell 1973	
Pell 1973	
Sataloff and Michael 1973	
Patterson 1974	
Stone 1974	

2.7 Educative Audiometry

This possible objective of audiometry implies that an audiometric examination is an occasion for educating workers into wearing hearing protectors that have been provided. This point of view has been proposed or supported by several writers although few statements of the opposite point of view can be found in the literature (see Table 12). One of these dissenting writers is Howell (1973) who declares that such a use of audiometry is, "...Surely a sledgehammer to crack a nut; an expensive exercise to achieve such a limited objective? This is not what audiometry is all about!" However, not a single scientific study has been so far reported which tests the hypothesis that audiometry influences the wearing of hearing protectors. This is possibly because of the difficulty of identifying the locus of action of audiometry in this matter as there appear to be three ways in which audiometry could achieve this objective, assuming it to be successful in doing so. The first way is that of simply providing an occasion for telling workers why they should wear hearing protectors. This is indisputable, but not unique to audiometry. After all, any situation in which workers come into contact with the medical department (or the safety department or the training department-department) could be used as such an occasion. Indeed, it would probably be easier and more apposite to organise meetings and talks to drive the point home. In this case, audiometry would be an extra of slight additional value and no more. The second way is that of providing an opportunity for presenting a recalcitrant worker with his audiogram showing the characteristic 4,000 Hz notch and shock him into wearing his hearing protection. The snag here is that this could only work for employees who have already suffered a loss in which case it could hardly be considered to protect employees from such loss. Also a new entrant with perfect or near perfect hearing or who is able to hear adequately is hardly likely to be impressed by this approach. The third way is based upon the assumption that audiometry, being a medical test performed by doctors and nurses increases the anxiety or arousal level of testees to some extent and that this, coupled with education in hearing protection, will make testees subsequently more likely to wear their hearing protection. Now there is evidence that such an effect occurs in other safety-related fields, but that the direction of the effect caused by increase in arousal is mediated by both the extent to which arousal is increased and the complexity of the action to be taken as a result of the accompanying education (Belbin 1956a&b Leventhal et al. 1965 and Piccolino 1966). Thus, the more the audiometry makes testees anxious (beyond a certain level) or the more difficult it is to obtain hearing protectors (again beyond a certain level) the greater is the chance that the wearing of hearing protectors may be *reduced* rather than increased according to this hypothesis. It is important to note in this context that the perceptions of management and medical departments of how easy it is for workers to obtain and use personal hearing protectors may not coincide with those of the workers themselves, and it is the latter which are more important if personal hearing protectors are to be worn.

Of course, as was pointed out earlier, there seems to have been no work at all carried out in this area and it may be the case that more hearing protectors are worn in factories where audiometry is performed than in areas where it is not.

But we must not ignore the possibility that other methods may do the job better. Research is needed in order to decide this issue and indicate whether or not this objective of audiometry is not simply one of the rationalisations warned against earlier.

2.7.1 Audiometry as Tangible Evidence of the Concern of Employers for the Hearing of their Employees

Educative Audiometry, as the term has been used, is an umbrella term covering not only attempts to induce behaviour change in workers (i.e. wearing personal hearing protectors provided) but also to encourage them to believe in their employer's efforts to protect their hearing. Two authors who suggest that audiometry may serve this purpose are Dawson (1973) and Ensell (1973). The former says, "An emotive, but not insignificant, factor in our labour relations is the simple demonstration that we really do care!" Ensell (1973) says in reference to audiometry in his company that, "It is another tangible event in the exercise of our policy of rigid control of "need to be present" in our areas of excessive noise." Ensell's statement is perhaps strangely phrased but taken together they suggest a need by companies to be seen to be doing something to combat the undesirable effects of noise upon hearing. Only the two references quoted have been found in the literature, but from interviews conducted with industrial medical officers by the author, the impression was gained that many people in decision-making positions in industry felt that workers would perceive audiometry as being evidence of the concern of their employers for their welfare.

This claim at first seems unimportant, especially when so little of the literature refers to it, but in reality it is quite major. It suggests that companies may perform audiometry to enhance their credibility as protectors of hearing in order to increase the likelihood that their efforts to protect hearing will receive co-operation from workers. But what if the claim should be false? This might imply a cynical attitude on the part of workers towards audiometry which may, in turn, militate against any persuasive or educative effect it may have upon the wearing of personal hearing protectors. Such being the case, then audiometry would be a waste of already scarce resources.

Obviously no published work has been done on this point and so this must be considered a serious gap in knowledge of the effect of industrial audiometry. This will be referred to again later.

TABLE 12 Audiometry as a Means of Encouraging Workers to wear Hearing Protectors that have been Provided

Authors Expressing Opinions in Favour of Audiometry's Usefulness for this Purpose	Authors Expressing Opinions Against Audiometry's Usefulness for this Purpose
Bell 1966	Gregory 1973
Watson 1967	Howell 1973
Murphy 1969	
Wyman 1969	
Hamilton 1970	
Heijbel 1970	
Coles 1973	
Coles 1973	
Dawson 1973	
Ensell 1973	
Pelmear 1973	
Sataloff and Michael 1973	
Trevithick 1973	
Pelmear and Hughes 1974	
Thomas et al. 1975	
Somerville 1976	

2.8 Summary of Chapter 2

1. The evidence relevant to the use of audiometry in industry was discussed and summarised. It was concluded that the unreliability of audiometry makes it of doubtful utility in the monitoring of hearing-level changes of individuals though it may be useful for monitoring mean hearing-levels of groups of individuals, provided normal scientific controls are employed. It was concluded that the evidence concerning the cost of industrial audiometry is scant and that the validity of audiometry as a predictor of social disability is open to some doubt.

2. The uses to which audiometry may be put in industry were divided into five categories:-

   (a) Pre-Employment Baseline Audiometry,
   (b) Case-Finding Audiometry,
   (c) Group Monitoring Audiometry,
   (d) Diagnostic Audiometry,
   (e) Educative Audiometry.

Categories (a) to (d) were included under the general heading of Screening Audiometry.

3. The validation of medical screening procedures was discussed, both in general and with specific reference to industrial audiometry.

4. The five categories into which the uses of audiometry were divided were discussed individually. It was shown that the overwhelming majority of the writers, whose opinions were reviewed, supported the ability of audiometry to satisfactorily perform at least one of the uses proposed for it.

CHAPTER 3

DEVELOPMENT OF THE RESEARCH PROBLEM

3.1 Problems Emerging from the Literature Review

To reiterate what is apparent from the literature review, the writings on industrial audiometry fall into two classes; personal opinions based upon little evidence or upon other personal opinions, and evidence based upon attempts at controlled studies. This is not unusual in any field of human endeavour but in the present case, it would seem that, all in all, the controlled studies relate to the technical aspects of audiometry while it is the expressions of opinion that relate to the questions identified in the Introduction. This may be because the technical aspects of audiometry are not relevant to the questions but are the easiest to study. In other words, it is analogous to searching for a lost coin beneath a street lamp in an otherwise dark street, not because you have reason to believe the coin is there, but because you can see better there. It may also be that some of the answers to the questions are suspected and may be embarrassing to some people in industry. For example, it may be that the decision to start a programme of audiometric testing may be taken upon non-medical considerations. This is the crux of the matter in the Pre-employment Baseline Audiometry section above in which it was shown that the desire to protect the company purse was an important consideration behind establishing a reliable baseline. If such an objective were widespread then there would be many in and around industry interested in hearing about it. But of similar importance to those involved in decision-making is the validity of the claims made for audiometry. It is vital to know why others perform audiometry so that the pitfalls may be avoided and it is also vital to know what the gains from audiometry are likely to be if the correct decision is to be made. So if any meaningful statement is to be made about the value of audiometry in industry, it is necessary to investigate why audiometry is being done and the validity of the claims being made for it.

3.2 The Claims Made for Audiometry

It seems, therefore, that underneath the objectives of industrial audiometry as have been outlined lie a number of fundamental claims that have been made for audiometry when it is used in industry. In order to gauge the amount of light cast by previous writings upon the questions asked in Chapter 1, it is necessary to assess the implications of the literature reviewed for these fundamental claims. It is instructive to consider each one in turn.

i) Audiometry can be used to monitor the effectiveness of a hearing conservation programme.

Audiometry may or may not be useful in monitoring the effectiveness of a hearing conservation programme but two factors must be taken into account in deciding one way or the other. These are:

a. are the reliability and validity of audiometric testing in this circumstance sufficient to justify its use? and,

b. what is the definition of effectiveness?

The first is a technical point, the second is more basic. An investigation of the latter requires either that a survey be undertaken to discover the definition in common use before an investigation of the former can take place or that several different definitions are taken and a separate technical investigation is undertaken with each. The technical a fuller discussion of the investigations made has been included earlier.

Evidence with regard to this claim is vital for if, as was suggested in the Introduction, a medical practitioner is inclined towards trying to protect the individuals within the population for which he is responsible rather than the population as a whole, then audiometry must be reliable enough to do this. However, the evidence reviewed supports the conclusion that audiometry is too unreliable a test to be useful for anything other than the comparison of group means. This being so, then audiometry would seem to add nothing to the contribution of engineering approaches to the prevention of noise-induced hearing-loss. Thus, the more rigo rous studies that have been reviewed suggest that companies should not perform audiometry, or at least that there is no point in performing audiometry. However, the other claims must be examined before this can be stated as a firm conclusion.

ii) Audiometry increases the probability that hearing protectors, once issued, will be worn

The claim that audiometry increases the probability that hearing protectors, once issued, will be worn means simply what it says, although wearing hearing protectors and wearing them properly are two different things and it is the latter which is the more important. These two questions must be investigated in order for it is necessary to show that hearing protectors are worn at all before one can move on to find out if they are worn properly. Added to this, the claim that is made is simply that audiometry will, in some way, cause hearing protectors to this subject, what is needed is to concentrate research effort upon the claim as stated.

iii. Audiometry is perceived by workers as being evidence of their employer's concern for their welfare

The claim that audiometry is taken by workers to be evidence of their employer's concern for their welfare was mentioned in the section on Educative Audiometry. The basis for it is not clear, but would seem to stem from a patronising view of occupational medicine coupled with a certain diffidence on the part of managers and medical officers. Also should the claim be true, the value of such truth is open to debate. It may be the case that it is assumed that if workers see that their employer cares about their welfare then they will accept measures introduced to protect them. A more cynical view is that is means workers can be easily fooled into happily accepting measures motiviated purely by employer self-interest. The claim is important and should be investigated.

iv) Audiometry is a medico-legal adjunct

The final claim is that audiometry is useful in the medico-legal sense. This is a claim that can be viewed on several levels. Does audiometry have any legal standing? As discussed earlier, this question is not settled and in any case is completely outside the scope of scientific inquiry. Should the decision to use a medical test be based upon anything other than medical considerations? This is where an overlap can be seen between the claims being made for audiometry and the reasons for which it is being done. If audiometry is useful in the medico-legal sense, to whom is it more useful, workers or employers?

This question cannot be answered until medico-legal utility has first been established. The only question open to scientific investigation is whether or not audiometry is believed to be useful in the medico-legal sense, or, in operational terms, is there an association between audiometry and common law claims for alleged occupational deafness?

3.3 Approaches to the Investigation of These Claims

It would appear, from the discussion of these claims, that the evidence so far adduced does not support the claim that audiometry can be used to monitor the effectiveness of a hearing conservation programme in the way that an industrial medical officer might wish. All the remaining claims remain open to investigation. However, the only claim that is open to a direct observational approach is the claim that audiometry will increase the probability that hearing protectors, once issued, will be worn. All else must be investigated by the indirect method of answering the question "why is audiometry performed or not performed as the case may be?" This approach necessitates examining the attitudes of the antagonists in the controversy towards industrial audiometry. Also it is apparent from work already performed that the views of one group in particular have been largely ignored - the workers. After all, it is important to know what they think about audiometry and hearing protection to see if they have any basic objection to what is being done ostensibly on their behalf. It would seem that what is being done is merely an attempt to "sell" them a solution which may or may not be acceptable to them on a basic level. It is thus equally as important to examine their attitudes towards audiometry and hearing protection as it is to examine the attitudes of the decision-makers.

3.4 Industrial Audiometry as a Medical Screening Procedure: Specific Considerations

The problems, questions and explanations discussed so far lead back to the area of medical screening which can be used as another rubric for discussing the review of the literature. In the section on screening audiometry, the general question of the validation of medical screening procedures was touched upon and the writing of McKeown was used to make the point that two types of criteria are considered important in such validation, namely, biological and economic. The biological criteria were, a knowledge of the natural history of the condition in question, the ability of screening to identify the condition at an early stage and the existence of methods of "treatment" or care which are effective. The economic criteria were, obviously, cost-related with the reliability of the procedure being a vital consideration. The question is, does industrial audiometry satisfy these criteria?

If we take the natural history of industrial hearing-loss, it would seem that this is well understood. This is not, however the case. The relationships between noise and hearing-loss is known, but on a probabilistic basis. The work of Burns and Robinson (1970) cited earlier does not permit us to predict which individuals in a noise-exposed population will sustain a hearing-loss of a particular degree. Also there is no definitive test of exaggerated susceptibility to noise in an individual. The use of audiometry for this purpose has been proposed, but its ability to do so has not been adequately demonstrated for the same reason that the ability of audiometry to detect hearing-loss at an early stage is in dispute - unreliability of the technique. Also, it must be noted that noise is not the only possible cause of hearing-loss because age and pathology are also possible causes. Loss due to age (presbycusis) is, like loss due to noise, understood in a probabilistic manner and because of this and also because the types of hearing-loss produced by these two causes are similar in important ways it is extremely difficult to assess their relative contributions in an individual. Thus, an individual who works in a noise environment may have an identifiable hearing-loss, but there may be two confounding explanations for it.

This last sentence assumes that one is able to identify hearing-loss in an individual. This, of course, is true. If someone possesses a progressive hearing-loss, then sooner or later, it will be noticed. But can audiometry detect such a loss in an early, preferably presymptomatic, stage? As has already been discussed this matter is in some dispute but the answer appears more likely to be no.

However, and more importantly, audiometry can only detect a hearing-loss which has already occurred and which, because of the nature of noise-induced hearing-loss (and presbycusis for that matter) cannot be reversed. This has important ramifications for the third biological criterion - the availability of an effective treatment. An individual who is deemed to be suffering from a noise-induced hearing-loss can either be moved to a quieter working environment, or provided with personal hearing protectors. The former solution tends to be met with disfavour by workers and managements alike and the latter meets with problems that will be discussed later. Also these medical or quasi-medical solutions contrast with the alternative purely engineering solution of noise control mentioned in Chapter 1.

Noise control is by far the best solution to the problem of noise-induced hearing-loss since, if the level of noise produced by machinery or processes is reduced to a safe level (assuming such a thing to exist), there can be no problem. Noise control can be expensive, though, and there is also a tendency on the part of industrial managers to believe noise control to be expensive by definition (Else, 1976a). Personal hearing protection therefore tends to be favoured with audiometry often being used in conjunction with it. The question then becomes: are the economic criteria for validating a medical screening procedure satisfied by industrial audiometry? The answer to this question is uncertain for, while the reliability or otherwise of industrial audiometry has been discussed at great length already, the literature pertaining to the cost of performing audiometry (reported in the section on Pre-employment Baseline Audiometry) is scant and vague.

It seems that the literature concerning the use of audiometry in industry fails to validate such audiometry as a medical screening procedure in that the evidence is either unfavourable or inconclusive. But is must be said that no systematic project designed to try and validate industrial audiometry as a medical screening procedure appears to have been undertaken to date. All the evidence presented so far has concerned aspects of the issue in a piece-meal fashion. Such a project would be a valuable and important one to undertake and would fill a gap in our knowledge. However, such a project is not the only approach to the problem. An alternative approach is one which goes behind the problem following the lines discussed earlier in this chapter. A rationale for this can be discoveredby looking at the literature on the usage of personal hearing protectors.

3.5 The Usage of Personal Hearing Protectors

The work of Else (1973, 1976a & b) highlights important problems and considerations in the provision and use of personal hearing protectors and alerts one to the possibility that there is more to a programme of personal hearing protectors than simply issuing them and that ensuring that such protectors are worn may be a problem. For example, a survey of 100 factories undertaken by Her Majesty's Factory Inspectorate in 1971 indicated that only 4% of hearing protectors issued to workers exposed to noise were being worn (H.M. Chief Inspector of Factories: Annual Report 1974). This same report spoke of a follow-up survey undertaken in 1973/74 which indicated that this proportion had risen to 11%. These are very low figures. However, this report gives no information on how the data was collected, that is, whether it was by direct observation or by interview or whatever. A report of Heijbel (1970) does provide such information in that the method of data collection was that of interviewing workers individually. Heijbel reports on three such surveys of hearing protector usage undertaken at the Volvo engine production works in Sweden, the first being in 1959, the second being in 1961 and the third in 1967. His figures fall into three categories, workers who wore hearing protectors "all the time", "occasionally", or "never". The 1959 survey reported usage rates of 28.0%, 9.2% and 62.8% respectively in these three categories. The 1961 survey reported figures of 38.5%, 9.7% and 51.8% respectively while in the 1967 survey these figures were 59.0%, 15.8% and 25.2%. These figures represent a steadily improving trend which Heijbel attributes to an active programme of audiometric testing combined with lectures and exhortations to testees to wear hearing protectors. (Only one type of personal hearing protector appears to be provided at this particular factory - glassdown earplugs). However the definitions of the three categories used by Heijbel are not given and interviewing must be considered a method of doubtful validity in collecting information of this type owing to the possibility of an interviewer unwittingly leading interviewees in a certain direction, possible unintentional biases in recording responses, unreliable recall on the part of the interviewees, attempts on the part of interviewees to "please" the interviewer by giving the information which they think the interviewer wants, and so on. Safeguards against interviewing biases can be included in an experimental design but Heijbel gives no indication of the safeguards he took.

Sugden (1967) reported the initial stages of a campaign to provide glassdown earplugs for about thirty men in an iron foundry. Sugden was able to use direct observation and found that although initial usage was high, after six weeks only about 30% of the men were wearing the earplugs regularly.

Lob (1971) reported the outcome of an attempt to provide earplugs of various different types to the workers in a wire-drawing factory in Switzerland. All employees attended lectures about the effects of noise, and audiometry coupled with personal interviews was used. Direct observation was possible on the small workforce (54 employees), but only 13 workers (24% approximately) appeared to wear the earplugs on any kind of regular basis.

The author of this thesis also received the reports on this theme of two relatively large British companies (which gave the information on the understanding that confidentiality would be maintained). The writer of the first report undertook his survey in August 1971 by means of randomly selecting workers in noisy areas for interview. He presented his data by factory area. In twenty-one such areas, the highest percentage of usage of the glass-down plugs was 30.8% and the lowest was zero, which was the result from seven areas. The writer of the second report undertook his survey in 1974 in similar fashion to the author of the first report. Both earplugs and earmuffs were provided. 71% of workers provided with personal hearing protectors wore them 'full shift' (although 25% said they were "not satisfied" with them), 19.5% wore them 'part shift' and 9.5% did not wear them at all. Once again these categories are not defined.

These studies demonstrate two points:-

(a) it cannot be assumed that hearing protectors, once issued, will always be worn by all their recipients for all of the time necessary,

(b) the usage rate is subject to great variability.

Keeping within the medical screening framework, point (a) means that the "treatment" implied by audiometry may not be universally acceptable by those receiving it, while point (b) suggests that this acceptability is capable of being influenced to some extent at least. The questions here are, "why are personal hearing protectors largely unacceptable?" and "what factors increase or decrease their acceptability?" It is possible that the answer to the first question may make the second question redundant. This is analogous to another medical screening procedure in a different medical field, namely, cervical cytology. This is a procedure which satisfies the biological and economic criteria laid down earlier to a very large extent and, as a result should be effective in reducing cervical cancer. However, it suffers from the problem of not being used by the population of women most at risk from this particular form of cancer (Knox 1966). Apparently, those women who do submit themselves to the so-called cancer smear test, tend to be from social groupings in which the incidence of cervical cancer is low anyway while women from social groupings in which the incidence is relatively high do not come forward (because they dislike the test or the perceived treatment, perhaps?). The target population is missed, thus rendering cervical cytology largely ineffective despite its apparently satisfying the important indices of effectiveness.

3.6 A Third Type of Criterion for Evaluating a Medical Screening Procedure

The point just discussed suggests that attempts to validate a medical screening procedure using biological and economic criteria alone are not sufficient. Necessary, but not sufficient. Instead a third, additional type of criterion is required - a motivational or attitudinal type. Thus a medical screening procedure should not be considered valid until it is shown to satisfy the biological and economic criteria and it is shown to be acceptable to testees both in execution (the test itself) and treatment resulting from it. Additionally, it must be shown that those who instigate and run a programme of medical screening are doing so for logical or empirical reasons and not as a result of a particular bias of thinking. Thus with industrial audiometry to which there is an alternative, engineering approach to the problem in question, the focus of interest should be whether audiometry is performed in addition to or as an alternative to noise control,because that is the best way to tackle noise-induced hearing-loss or because those who perform audiometry in industry are biassed towards perceiving any problem as a medical screening problem regardless of its intrinsic characteristics. Conversely, those who refuse to perform audiometry in industry may do so with good logical and empirical reasons or because of their own particular bias. Either way, it may be a case of refusal to accept reasoned argument or fact or, on the other hand, the rationale may be correct. Validity can be claimed only when the latter is true.

If, as is the case with industrial audiometry, the remedy of choice to the problem which is the raison-d'etre for the test is, in some sense, prophylactic rather than curative, then a corollary of the motivational or attitudinal criteria of validity is that the test itself may influence the acceptability of the remedy. Thus if one is going to provide workers exposed to noise with personal hearing protectors anyway, then performing audiometry upon these workers, perhaps on a regular continuing basis, may persuade more of them to wear their hearing protectors. This is an example of a procedure which begins life as a screening test but which eventually becomes seen as a motivating device as well. Furthermore, it is the outcome of an interaction between the motivational or attitudinal criteria and the aims of the test which occurs because these criteria are ignored in validating the test. It may be the case that audiometrically testing workers will convince them that they should use their hearing protectors or it may not be, but if one is aware of the need to ensure that audiometry satisfies motivational or attitudinal criteria as well as biological and economic ones, then one is less likely to assume that it is the case and more likely to search for evidence that this is so. Earlier in this section the claim by proponents of audiometric testing in industry that audiometry encourages workers to wear hearing protectors provided was isolated. This claim illustrates nicely how this third type of criterion is ignored. It does so on two counts. The first is that it is an assumption in the manner described above. The second is that encouraging workers to wear hearing protectors is not enough if, say, usage is caused to increase from 4% to 30% (both figures quoted earlier) because audiometry cannot be considered an effective attack upon noise-induced hearing-loss until a large majority of personal hearing protectors issued are being worn and worn properly. (The minimum percentage that constitutes an acceptably large majority has nowhere been defined and so must be considered a matter for further research.) Also, in the case of industrial audiometry, audiometry as motivator and audiometry as screening test seem to have become confused to the extent that some writers seem to emphasise the former (e.g. Pelmear 1973) and some the latter (e.g. Heijbel 1970).

However, the claim has been made and so it should be investigated because if it is true in overwhelming fashion, then one of the motivational or attitudinal criteria will be satisfied. The studies cited earlier in this section have not attempted to examine systematically this claim by comparing factories where audiometry is being done with factories where it is not. It is one of the aims of this present research to attempt to do this by direct observational methods.

The existence of a third set of criteria for validating a medical screening procedure is extremely important with wide-ranging implications. Thus, the emphasis of this thesis will be upon investigating whether or not industrial audiometry satisfies motivational or attudinal criteria. As was stated earlier, the ability of industrial audiometry to satisfy biological and economic criteria is an important piece of research in itself, but one of interest only to audiometry. Investigating industrial audiometry's satisfaction of motivational or attitudinal criteria is of interest to the whole field of medical screening in general as well as to audiometry in particular, and may be even beyond.

The next step is to examine the hypotheses implied by this discussion of the problems emerging from the literature review and the ways in which they may be tested.

3.7 Hypotheses for Testing

The discussion of claims and reasons and research approaches leaves us with three main hypotheses. However, two additional hypotheses can be generated by examining the possible mediators behind the claim that audiometry increases the probability that hearing protectors, once issued, will be worn. Three such mediators were discussed in the section on Educative Audiometry. One of these was self-evident, but the other two were worthy of investigation:

(a) that audiometry increases a worker's awareness of his hearing ability and the existence of hearing-loss;

(b) that audiometry increases a worker's fear of hearing-loss.

These can be directly translated into hypotheses.

Similarly, four more hypotheses can be generated from the claim that audiometry has medico-legal value. A company that conceptualises occupational deafness in terms of drain upon its financial resources will probably manifest this conceptualisation in more than one way. In addition to the claim discussed, one such way is the method adopted for preventing occupational deafness - the cheapest regardless of its relative efficacy. Thus, such a company could be expected to favour personal hearing protection over noise control at source. Similarly industrial medical officers, owing to training and to clashes of loyalty such as those discussed earlier, might be expected to favour personal hearing protection if they are amongst the number who perform audiometry. A corollary of this is that medical officers performing audiometry are more likely to conceptualise it

litigation or claims by workers for

compensation for alleged occupationally-induced deafness than are medical officers who do not perform audiometry at all. Such industrial medical officers might also be expected to place a different priority upon the prevention of occupational deafness from industrial medical officers not performing audiometry because of different ways of considering occupational deafness.

Therefore, the present research set out to test three main and six subsidiary hypotheses. The three main hypotheses are:

1. Performing audiometry increases the probability that hearing protectors, once issued, will be worn.
2. Audiometry is considered by workers to be evidence of their employer's concern for their welfare.
3. Audiometry is associated with common law claims by workers against employers for alleged occupational deafness.

The six subsidiary hypotheses are:

i. Audiometry increases worker's awareness of their hearing and of the existence of hearing-loss.

ii. Audiometry increases worker's fear of hearing-loss.

iii. Audiometry is associated with personal hearing protection as opposed to noise control at source.

iv. Industrial medical officers performing audiometry favour personal hearing protection over noise control at source.

.....

v. The priority placed by industrial medical officers performing audiometry upon the prevention of occupational deafness differs from that placed upon it by industrial medical officers not performing audiometry.

vi. Medical officers who perform audiometry are more likely to conceptualise audiometry in terms of its value in litigation or compensation claims made by workers for alleged occupationally-induced hearing loss than are medical officers who do not perform audiometry.

3.8 Summary of Chapter 3

1. It was shown that the evidence relevant to industrial audiometry and the majority of printed opinion about it are at variance with each other and it was suggested that decisions concerning the use of audiometry in industry are being made on a largely non-factual or non-rational basis.

2. Four claims made for industrial audiometry were identified. These are:-

   (a) Audiometry can be used to monitor the effectiveness of a hearing conservation programme,

   (b) Audiometry increases the probability that hearing protectors, once issued, will be worn,

   (c) Audiometry is perceived by workers as being evidence of their employer's concern for their welfare,

   (d) Audiometry is a medico-legal adjunct.

3. Approaches to the investigation of these claims were discussed and it was decided that the most useful one would be an approach relying upon the investigation of attitudes of all those involved.

4. Industrial audiometry was discussed as a medical screening procedure and it was concluded that the literature discussed failed to validate audiometry in terms of the biological and economic criteria because the evidence is either unfavourable or inconclusive.

5. The literature concerning the usage of personal hearing protectors in industry was discussed and it was concluded that such protectors are largely unacceptable to workers expected to wear them. It was suggested that if performing audiometry implies issuing personal hearing protectors (in the minds of those who decide such things in industry), then this is analogous to the treatment implied by a medical screening procedure being unacceptable. In this context it was suggested that a parallel may be seen between industrial audiometry and cervical cytology, a medical screening procedure known to satisfy biological and economic criteria.

6. It was argued that biological and economic criteria are necessary, but not sufficient, to validate a medical screening procedure. In addition, it is necessary to satisfy a third type of criterion - a motivational or attitudinal type. The criteria comprising this third type are that:-

(a) the test or procedure must, itself, be acceptable to testees;

(b) the treatment resulting from the test or procedure must be acceptable to testees;

(c) those who instigate and run a programme of medical screening must do so for logical or empirical reasons and not as a result of a particular bias of thinking.

7. It was also argued that the screening test itself may influence the acceptability of a remedy which it is proposed to apply anyway. Thus if personal hearing protectors are going to be provided to all noise-exposed workers anyway, then it could be argued, within a medical screening framework, that regular audiometric testing persuades more

workers to wear them than would have been the case without it. It was suggested that lack of awareness of the need for audiometry to satisfy motivational or attitudinal criteria may cause decision-makers in industry to assume this relationship between audiometry and personal hearing protectors to be true instead of searching for evidence that it is.

SECTION II: METHODOLOGY

CHAPTER 4

THE STRATEGY FOR INVESTIGATING THE PROBLEM

4.1 Research Strategy

The strategy of the present research involves questionnaires supported by surveys of hearing protector use and extended interviews with representatives of companies performing audiometry and companies not performing audiometry. In this way, the hypotheses could be tested with data from one or more independent sources. The recipients of the questionnaires were workers and industrial medical officers although different questionnaires were used on these two populations. The aim of the questionnaire given to industrial medical officers was to gather information on:-

(i) The types of hearing conservation programmes they were involved in.

(ii) The way they educated the populations for which they were responsible about the problem of occupational deafness.

(iii) Why they did audiometry (if at all).

(iv) Why they felt others did it.

(v) Their attitudes towards audiometry, personal hearing protection, and noise control at work.

(vi) Their employers' involvements, if any, in common law claims.

(vii) The relative priorities they would assign to preventing various occupationally-induced injuries and disorders (including occupational hearing-loss).

(viii) Various personal details.

The purpose of this was to obtain data pertinent to the research hypotheses and also to obtain extra data which may be meaningful in a serendipity fashion. Two questionnaires were given to workers; one concerned with audiometry ("hearing tests conducted at work" or some variant thereof as it was called in the questionnaire) and one concerned with personal hearing protectors ("earmuffs and earplugs"). Owing to the orientation of the research towards investigating a possible link between audiometry and hearing protection, it was considered necessary to give questionnaires, probing both of these things to workers exposed either to both of them, neither of them or one or the other of them in order to get a picture of the link and the interaction between them. The purpose of each of these questionnaires was to provide an insight into the kinds of dimensions used by workers in conceptualising both audiometry and hearing protectors. One of the main hypotheses (hypotheses (2)) and two of the subsidiary hypotheses (hypotheses (1) and (2)) are simply postulates of conceptual dimensions - workers either think in those terms or they do not. Thus, the two questionnaires were intended to:

(a) find out if these postulated conceptual dimensions do, indeed, exist,

(b) discover other such dimensions which have not been considered to exist previously, and

(c) discover how workers rate audiometry and hearing protectors in terms of these dimensions.

In other words the purpose of these two questionnaires was both that of testing hypotheses and that of mapping out a field of interest. The type of analysis selected for this purpose was that which is loosely called Factor Analysis, a technique for discovering groups of inter-relationships underlying the intercorrelations between a series of tests or (as in this case) the items on a test. For a fuller explanation of what Factor Analysis does and the problems associated with its use, see the Factor Analysis section later in this thesis which also outlines the reasons for the selection of this type of analysis.

Subsidiary hypothesis (6) is similarly a postulate of a conceptual dimension and so the same line of reasoning as that just used above can be applied to it and to the attitude questionnaire at the end of the medical officers questionnaire.

4.1.1. The Samples of Respondents

In the case of the workers, it was obviously only possible to use relatively small samples from representative companies. In the case of the industrial medical officers, it was possible to use the entire identifiable population as the sample. However, there were two difficulties. One was that the questionnaire had to be a postal one and as such was prone to the usual problems which beset such questionnaires (Scott 1961). The other was that of defining the population because of the lack of any kind of inventory or register of industrial medical officers. The solution adopted was that of defining the population as consisting of the members of the Society of Occupational Medicine and the medical members of the British Occupational Hygiene Society. Thus the population used may be open to a charge of non-representativeness owing to its self-selected nature.

4.1.2. Summary of the Research Strategies

So if we take the research hypotheses in order, the strategy adopted was that of testing main hypothesis (1) by means of the personal hearing protector use surveys backed up by the two workers' questionnaires, main hypothesis (2) by means of the two workers' questionnaires, main hypothesis (3) by means of the industrial medical officers' questionnaire. Similarly subsidiary hypotheses (1) and (2) were tested by means of the two workers' questionnaires, subsidiary hypothesis (3) by means of the medical officers' questionnaire and the extended interviews referred to earlier, and subsidiary hypotheses (4), (5) and (6) by means of the medical officers' questionnaire.

4.2 Historical Development of the Research Strategy

4.2.1 Early Impressions of the Project

This section is an outline of the historical development of the methods used in the research described in this thesis. In the beginning, the literature search discussed earlier was undertaken in order to ascertain what research work had been done on industrial audiometry to date and to try and identify the area where efforts could be most profitably centred. In addition to this literature search, people in the occupational safety and health field in industry who might have had some involvement with audiometry were also visited in order to see if there existed any undercurrents not readily apparent from the literature. The people met included medical officers, safety officers, occupational health nurses, various managers and also an epidemiologist who had done some work on audiometry including experimental work reported in the literature. After a while, it became plain that a controversy existed as to the value of audiometry in industry with two distinct and entrenched positions existing on the subject - a "pro-audiometry" school and an "anti-audiometry" school. As in any such controversy, claims and counter-claims were rife. Yet it seemed that many of the claims were not based upon facts, but on assumptions. Claims such as the one that held that audiometry increases the use of hearing protectors or the claim that performing audiometry makes workers feel that management is concerned for their welfare and counter-claims such as the one that maintained that money spent on audiometry was money better spent on more productive ways of preventing hearing-loss, seemed to be based upon such assumptions. Nonetheless, positions were still being struck and vehemently adhered to. So it was decided that what was required was to see if any light could be thrown upon any of these unsupported claims and also whether any light could be cast onto why industrial audiometry was so controversial. It seemed that there had to be emotional factors involved. Also the initial look at industrial audiometry viewpoints and evidence gave the impression that one major group of people was being ignored by the antagonists in the controversy, namely the workers themselves. No-one seemed to be interested in whether workers thought they should have their hearing tested or not or in what they really thought about hearing protectors. It was possible that workers might have some basic dislike of hearing protectors which might be soundly based enough for some alternative prophylactic strategy to be more worthwhile. Similarly with audiometry itself. It was determined, therefore, to try and assess the attitude of workers towards audiometry and towards hearing protectors.

4.2.2. Some Practical Problems of Research that were Encountered

With regard to research efforts directed towards workers, it was decided to compare companies that performed audiometry with companies that did not on a fairly large number of variables. This proved to be more difficult than had been anticipated. Because the research method involved the use of questionnaires (the development of which is described below) to be administered with workers as subjects, a number of companies seemed to take the view that it might "stir the workers up" (as one personnel manager put it) and so they felt safer in not agreeing to help. Also some companies were dubious of the ability of anyone to walk around a workshop counting the number of people wearing hearing protectors without being perceived as counting something - apparently a thorny point of industrial relations. (In fact a manual counter concealed in a pocket was used). All but one company refused permission to walk around their factory unaccompanied and because of this, it was not possible to make repeat measurements in a satisfactory manner. Hence the data collected were limited.

4.2.3 How the Sample of Industrial Medical Officers was Obtained

The approach to the question of why industrial audiometry had any significant effect upon the type of effort put into preventing hearing-loss was to be based upon a questionnaire. The respondents were to be industrial medical officers, safety officers, occupational hygienists, occupational health nurses, and industrial managers. The only feasible way of administering such a questionnaire was by post and analysing the results by computer. However, the potential number of respondents was so large that the logistics of such an operation were too great for one person to cope with. The Institution of Industrial Safety Officers alone assessed their membership at over 2,000. It was decided, therefore, to concentrate solely upon industrial medical officers as these were the people most actively involved in the audiometry debate. There was still a sampling problem to overcome in that it was impossible to estimate the number of medical practitioners actively involved in occupational medicine (Report of the Robens Committee 1972), and the British Medical Association was unable to assist. The best that could be done was to use the members of the Society of Occupational Medicine and the medically qualified members of the British Occupational Hygiene Society as the pool of respondents, a total of 895 in all. This was probably a reasonable sample (albeit self-selected and "interested" compared with others in occupational medicine, (Sawtell and Cooper 1975)) in that the people most active in the audiometry debate were likely to be members of one or the other of these societies and the memberships of these societies were likely to represent a fair cross-section of British industrial companies. The questionnaire that was used consisted of three parts. The first was a group of general and specific questions based upon the exploration of the field mentioned earlier. The second part consisted of a short series of demographic questions which was not essential to the study, but which was included to make the questionnaire "look like a real questionnaire" (Scott 1961). The third part of the questionnaire consisted of a Likert type attitude questionnaire.

The development of this questionnaire will be dealt with later alongside the other questionnaires that were used.

4.2.4. The Development of the Questionnaires

Initially the focus of interest was the measurement of attitudes. Attitudes of workers and attitudes of medical officers towards audiometry, amongst other things. So the traditional attitude testing techniques of Psychology-Guttman scaling, the Thurstone technique, Likert scaling were considered. Guttman scaling is appropriate for the study of attitude change or the hierarchical structure of an attitude, neither of which it was intended to study. Also the construction of a Guttman scale is extremely tedious, and, because of the nature of the technique, cannot guarantee the construction of a usable scale. Likert scales are the simplest of the three types of scale to construct and are also the most widely used but the more tedious Thurstone technique is often considered most appropriate for the study of group differences and so that was the method of attitude scale construction that was chosen as being most useful for the purpose of this research.

4.2.4.1. Thurstone Scaling

The Thurstone technique demands that a pool of attitude statements be drawn up and submitted to a panel of "judges" (a minimum of 40 judges is usually recommended) who are instructed to rate each attitude statement according to how favourable or unfavourable it is towards the attitude in question by means of an eleven-point scale with eleven representing the most favourable point, one the most unfavourable point, six the neutral point and so on. (In fact, the use of an eleven-point scale is purely arbitrary and other scales, such as seven or nine-point scales can be used. However, eleven-point scales are the more usual and so, for that reason, such a scale was used). A scale score can then be assigned to each attitude statement by calculating the median value of the judges' ratings and, at the same time, ambiguous statements (statements receiving a wide spread of ratings) can be eliminated. The most vital aspect of this process is the judging itself. Judges should not allow their own attitude to interfere with their ratings but should instead rate each statement as objectively as possible according to its favourability or otherwise towards the attitude in question. Also judges should be representative of the population to which the completed questionnaire is to be applied. These conditions proved difficult to satisfy.

For the proposed medical officers' questionnaire, a pilot run was made using 34 postgraduate students and members of staff of the University of Aston in Birmingham as judges to see how best to phrase the instructions and also to eliminate the most ambiguous of the statements. In addition to a written set of instructions, verbal instructions were also given to each judge yet difficulty was experienced in explaining the precise nature of the task to many judges. Also when the returns were analysed it was found that elimination of the ambiguous items according to the criterion adopted reduced the original pool of 169 items to 20. This suggested that either the original pool of items was poorly constructed or that the instructions to judges were inadequate. This posed problems for the administration of the attitude statement pool to judges drawn from the ranks of industrial medical officers because this exercise would have needed to be conducted by post if it were to be practical in terms of time and money. Also earlier research has shown that heavily prejudiced judges perform the task in a biassed fashion (Hovland and Sherif 1952) and as there was reason to suspect that a number of the judges employed would be prejudiced it was realised that it could take some time to obtain a minimum number of 40 sufficiently objective judges. With regard to questionnaires designed for use on worker populations, it was felt that as such populations were likely to be more test naive than the judges used to date then the problem with task instructions would be exacerbated. The attempt to construct questionnaires using the Thurstone technique was therefore abandoned and the Likert technique was turned to instead.

4.2.4.2. Likert Scaling

The Likert technique is less laborious than the Thurstone and also correlates well with it (Hovland and Sherif 1952). The first stage of this technique is the construction of a pool of attitude statements. Basically such a pool contains items which the investigator feels to be representative of the attitude he or she is studying. These items should be drawn from the investigator's knowledge of the field. In the case of the present research, the two questionnaires for the workers were developed first by devising a pool of 131 attitude statements concerning audiometry and a similar pool of 147 statements concerning hearing protectors. By the elimination of double-barrelled statements, statements which contained double negatives, other apparently very ambiguous statements, and statements which appeared to be repetitions in another guise of other statements, these pools were reduced to 34 and 47 statements respectively. This process of pool construction is one of the great vagaries of attitude questionnaire development. On one hand there is the problem of sampling the universe of possible statements and on the other there is the vague nature of the actual construction of the pool from the statements one has invented. The writing of successful attitude statements demands, as Oppenheim (1966) puts it "...careful pilot work, experience, intuition and a certain amount of flair." These reduced pools were then tested on a group of workers in order to see if any of the remaining statements were difficult to understand in any way. For example, the statement "hearing protectors are a boon to industry" proved to be unintelligible to a number of respondents who were not familiar with "boon". As a result, the pools were further reduced to 27 and 32 items respectively.

It would probably have been better to have tested the original pools of statements on a group of workers. However, there were time constraints upon the use of workers during company time and so it would not have been practical. The 81 attitude statements that were actually used took approximately 30 minutes to administer. The original combined pool of 278 statements would, by extrapolation, have taken nearly two hours. It is probable that fatigue would have been an important factor because the 81 statements actually administered seemed more than enough for some respondents.

The next step in the Likert scaling technique is to administer the remaining pool of items to a group of respondents as though it were the completed test. That is, the respondents are instructed to indicate their degree of agreement or disagreement with each statement along a five-point scale ranging from strongly agree through uncertain to strongly disagree. These five points are given numerical values usually ranging from one to five. The next step is to weed out those statements that do not measure what the test as a whole is measuring. This is a vital part of the process because the aim of Likert scaling is to produce a unidimensional or internally consistent questionnaire. Put simply this means that in a questionnaire designed to measure attitude towards audiometry then every item on the questionnaire must tap this attitude and not something else peculiar to itself. Idiosyncratic statements must be eliminated and the way this is done is by item analysis.

Item analysis consists of correlating each individual item with the total score obtained from all the other items on the test. This is based upon the assumption that items measuring the same thing will correlate with each other while an idiosyncratic item will fail to correlate highly with the remaining items on the test. Obviously, if one has a questionnaire of, say, 20 items, three of which are idiosyncratic then item analysis will be inaccurate because every correlation calculation will contain idiosyncratic statement scores in at least one of the correlation variables. The inaccuracy will be slight, though. But what if half of one's attitude statements are idiosyncratic? What if, in the example used, 14 of one's statements measure one attitude and the remaining six an independent attitude? In other words, item analysis is only valid apart from just a few idiosyncratic statements. It did not seem justifiable to make this assumption with regard to questionnaires used in the present research and so item analysis was abandoned in favour of the statistical technique of factor analysis.

4.3 Factor Analysis

4.3.1. General Description

Factor analysis is probably best explained by example. Let us assume that we are trying to discover how people perceive hearing protectors, what comes to mind when they are presented with them. We are trying to discover the attitude of people towards hearing protectors. Now a crucial question here is what is meant by attitude but, unfortunately, this is a question that cannot be answered definitively. Indeed, a whole area of Psychology is devoted to the question of defining attitude. But attitude questionnaires appear to be based upon the assumption that an attitude is a mental set that influences an individual's feelings towards the object in question either positively or negatively, assuming positive and negative to be poles on a continuum. Thus an individual's attitude towards hearing protectors may vary between good and bad. That is, he or she may feel that wearing hearing protectors is a good idea, a bad idea or he or she may be uncertain. There may also be varying degrees of good and bad. However, an attitude might not be that simple such that, in the hearing protectors example, people may not just perceive them as good or bad, but instead may perceive them in terms of their effectiveness as noise excluders, their comfort, their appearance and so on. Thus, in this case, the attitude in question act-of one another. These components may also be called dimensions or factors underlying the attitude. Now if, in fact, our hearing protectors attitude questionnaire were measuring three such separate dimensions then we would expect the responses to the statements relating to any one of these dimensions to correlate with each other, but not with responses to statements relating to either of the other dimensions. Thus if our questionnaire contained 20 statements, ten of which related to one of three dimensions, six to another and four to the third, then we would expect the ten statements to correlate with each other but not with any of the remainder and similarly for the six statements and the four. Such a pattern of inter-relationships would be apparent from the correlation matrix built up from our 20 statements, we would hope. Usually, though, the error and uncertainty associated with psychological measurement is such that the pattern is not obvious from the correlation matrix but has to be uncovered statistically instead. This is the function of factor analysis.

Because of this uncertainty just referred to, the end product of a factor analysis will simply be a count of the number of factors underlying the correlation matrix analysed plus a list of the attitude statements comprising each. Also in the correlation matrix itself, it is extremely unlikely that any two statements will correlate perfectly with each other. As a result a number of statements all tapping a particular factor or dimension will rarely do so to the same extent as one another. All this means that the factor analysis will tell us the correlation between each attitude statement and the underlying dimension.

It will do this for every statement in the questionnaire - those that tap the particular underlying dimension and those that do not, the important point being that only statements which really tap the underlying factor will correlate significantly with it. These statement-underlying dimension correlations are called factor loadings and in the case of a significant correlation the statement in question is said to load significantly on the factor in question.

4.3.2. Statistical Characteristics of Factors

Factor analysis, because of its computational complexity, is almost always only feasible when a computer is available. Also the factors are not all uncovered (extracted) simultaneously with each other. Instead they are extracted one at a time in descending order of amount of variance accounted for by each factor, the variance accounted for by a factor being the sum of the squares of all the loadings on that factor whether statistically significant or not. Thus, the first factor extracted will account for more variance than any one of the subsequent factors and so on. Now because each statement in a questionnaire is unique, a point will eventually be reached at which factors being extracted no longer reflect underlying dimensions in the sense described above, but instead reflect the uniqueness of particular statements. This reflection will be no more than an approximation of such uniqueness because every statement will have a loading on each factor, albeit insignificant statistically. Also, because the assessment of error in factor analytic computation cannot be performed completely satisfactorily, it is possible that factors with only a small number of significant loadings upon them may be such specific factors in reality. In addition a computer produces a mathematical solution and so later factors may simply be mathematical relationships between the original intercorrelations used in the analysis and, as such have no psychological meaning at all. Therefore, the identification of factors considered to be "real" is not obvious without the use of pre-determined criteria for distinguishing between the "real" and the "spurious". Similarly, we need criteria for deciding which loadings on a particular factor are statistically significant and which are not.

4.3.3. The Difference Between Factor Analysis and Principal Components Analysis

This is basically what factor analysis does but a semantic point is important here. Technically, there are two types of factor analysis:-

principal components analysis, and
factor analysis proper.

It is common practice, though, to use the term "factor analysis" to refer to both forms of analysis regardless. This is how the term will be used throughout the whole of this exposition (except where otherwise indicated in this paragraph), even though, in the technical sense, the type of analysis used in the present research was principal components. The difference between the two types of analysis lies in the mathematical assumptions concerning the nature of the variance. Principal components analysis assumes that all the variance is common factor variance, that is, there is no variance specific to individual items in the analysis. Factor analysis in the technical sense assumes that two kinds of variance exist:-

> variance specific to individual items in the test (specific variance), and
>
> variance shared in common by groups of items on the test (common variance).

At first sight principal components analysis seems the less plausible of the two, but in fact it is preferred for social scientific research because it relies upon fewer mathematical assumptions and, more importantly, factor rotations are possible. (The rotation of factors to simple structure will be dealt with below). Factor analysis in the technical sense tends to be preferred for engineering and so-called "hard" scientific applications. For the research reported in this thesis the choice of analysis and signficance criteria was guided largely by the excellent beginners book *The Essentials of Factor Analysis* by Dennis Child (1970) and, in no small part, by the limitations of the Aston University computer.

4.3.4. The Rotation of Factors to Simple Structure

It is necessary to describe that aspect of factor analysis referred to in the previous paragraph as factor rotation. The concept of rotating factors to simple structure, as it is called, came about as a result of the difficulties inherent in the naming of factors because once factors have been extracted from a correlation matrix, it is necessary to decide what those factors actually are in psychological terms. This is done by examining the attitude statements that load significantly on a particular factor and deciding what quality those statements share in common (See Appendix 3). Thus, in our hearing protector questionnaire example, the ten statements tapping the "effectiveness as noise excluders" factor would be all statements which refer, either directly or obliquely, to the efficiency of hearing protectors. Often, though, it may be difficult to see the quality shared by statements that load significantly on a particular factor. The reason that is usually given for this is that factor analysis gives the best mathematical solution to the problem it is presented with but that this may not represent the best psychological solution because no psychological assumptions are built into the mathematical manipulations. As a result, factors extracted by a factor analysis can be subjected to further mathematical manipulations according to psychological assumptions as to how statements should load on each factor. Different assumptions are possible and so different types of rotation are possible.

Three of the most commonly used forms of rotation are Varimax, Quartimax and Equimax, with Varimax being the most commonly used of the three. Varimax is based upon the assumption that a psychological dimension uncovered from a test by means of factor analysis should be defined by a number of test items all of which load perfectly upon it (that is load with a value of +1 or -1) while the remaining items on the test do not load at all (that is load with a value of zero). Factors are thus rotated until the best approximation to satisfying this assumption is achieved because the assumption represents an ideal which is never attained. In this way underlying psychological dimensions should be more easily identifiable. An alternative assumption is that each individual test item should load perfectly on one factor only and not at all on all of the remaining factors. This is the assumption underlying Quartimax and, as with Varimax, factors are rotated until the best possible approximation to the assumption is achieved. Equimax is an attempt at a compromise between these two assumptions. The intended outcome of such procedures are factors which do not contain bewildering contradictory statements and so are relatively simple to interpret. Hence the term "rotation to simple structure". However, the interpretation or labelling of factors remains the most controversial aspect of factor analysis.

4.3.5. Establishing the Validity of the Factors Extracted

The choice of the analyses and rotations that were used was governed by considerations mentioned earlier and also by the need to accrue evidence of the validity of extracted factors. Validity is a thorny problem in attitude measurement and one which is never solved to complete satisfaction (Oppenheim 1966). In other words, the validity of any attitude measure can always be open to some doubt. There are several major ways in which the degree of validity of an attitude can be estimated but the only one that was possible in present factorial research was to assume that any factor that had any real existence, and that was not an artefact, should emerge independently of the type of analysis performed. As a result, it was decided to analyse the data in a variety of ways. It was decided to use several types of factor analysis, each followed by several types of factor rotation. Because of the complexity of factor analysis calculations, such analyses can only, in any practical sense, be performed by a computer ready-programmed to perform them. The Aston University computer contained packages to perform two major types of factor analysis. One of them, however, contained no factor rotation facility and the Computer Centre

Advisory Staff advised that to perform a rotation of factors extracted from this type of analysis would not be valid as the analysis performed was factor analysis in the technical sense and not principal components analysis. Also it was specifically meant for engineering applications. It was therefore not possible to use it. The other package, it was discovered, after beginning to use it on the audiometry questionnaire data, had been adapted for use on the Aston University and, as a result, could handle less variables than the user handbook claimed for it. The handbook said that the package could handle a maximum of 65 variables and thequestionnaires contained 27, 32 and 27 variables (statements) respectively. In reality the package could only cope with 29 variables and so it was necessary for the biggest of the three questionnaires to use another package capable of handling all the variables which produced the same initial analysis but which, unfortunately, provided different rotational facilities. This is why, in the test, different rotations are performed on different questionnaires.

4.3.6. Implications of Factor Analysis for the Research Method

The decision to use factor analysis on the questionnaire data had two further implications for the development of the research method. The first was that the pilot work on the industrial medical officers attitude questionnaire (which was constructed after the decision to use factor analysis) was not so important as poor statements would simply fail to load on any significant factor. The second was that the calculation of reliability co-efficients was made hazardous without further research and was probably not essential as the purpose of the research was to explore new ground more so than to measure it.

4.3.7. Psychological Significance of Factors

With regard to the exploration of new ground, a hitherto unmentioned facet of factor analysis must be described. In the most basic sense, factor analysis is simply a mathematical manipulation of psychological test data and so the results of a factor analysis must be governed by the same constraints as the results obtained from any psychological test. The constraints of interest here refer to sampling for, just as a group of respondents is a sample of all the respondents it is theoretically possible to use, a group of test items is a sample of all the test items it is theoretically possible to use. Thus, if a test contains 20 items, then these items are 20 out of the possibly infinite population of items that could have been used. This constraint is not usually considered vitally important but, with regard to factor analysis, it has a major implication in that factors extracted are a function not only of underlying psychological dimensions, but are also a function of the items used on the test or questionnaire under analysis. What this means is that because of the nature of the test items used, psychological dimensions that truly exist may not be discovered by the subsequent factor analysis or may be sampled by the test in proportions uncorrelated with their psychological importance. Thus, if we return to the hearing protectors questionnaire example yet again, no "comfort" factor would have been revealed if no items on the test could be construed as relating in any way to comfort. This would not be to say that respondents do not perceive hearing protectors in terms of how comfortable they are but simply that the questionnaire failed to reveal such a thing. Also if a questionnaire containing, say, 20 items gave rise to, say, three factors - Factor A significantly loaded upon by twelve items, Factor B with five items, and Factor C with three - then it would not necessarily follow that Factor A is more important than Factor B which in turn is more important than Factor C because that is also the order of the number of significant loadings upon each. For the item-sampling reasons discussed above, the psychological importance of a factor is not a function of the number of items loading significantly upon it but the nature of those items. (Thus in reality, Factor C may be the most important of the three). This same consideration applies too to the amount of variance accounted for by a factor because as a general, though not inviolable, rule the greater the variance accounted for the greater the number of significant loadings and vice versa. Forgetting this is a common error in the interpretation of factor analytic results.

4.3.8. The Hypothetico-Deductive Approach to Factor Analysis

The effect of all this upon psychological test construction is to make the construction of a test revolve around the expectation that certain factors will emerge from the factor analysis. This is a more viable approach than the purely empirical approach of devising a set of items and seeing what factors emerge for it may be that so many factors exist that none are sampled adequately enough to reveal them or that so few exist that the items may miss them completely and uncover only randomness. The hypothetico-deductive approach is more conducive to advancing knowledge. It can also be applied with varying degrees of rigour. The existence of factors may be firmly hypothesised and written into the test or vague types of factor may be expected and these expectations used as anchoring points for the construction of the test. Neither extreme precludes the possibility of unexpected factors emerging or a single hypothesised factor actually revealing itself as two or more subtly different, but nontheless totally distinct factors. So in fact the hypothetico-deductive approach does not eliminate empiricism so much as temper it.

4.3.9. Factors Expected to Emerge from the Present Research Data

In the context of the research reported in this thesis, the preliminary interviewing and literature searching work led to the suspicion that certain factors would emerge from the various factor analyses it was intended to perform. Workers, it was felt, would conceptualise hearing protectors in terms of usefulness, appearances, comfort, hygiene or lack of it, freedom of choice to accept or reject them, responsibility for protecting hearing, and some masculinity-femininity dimension related to the sex-role mores of our society. Audiometry, it was felt, would be perceived by workers in terms of usefulness, freedom of choice, responsibility for testing hearing if at all, awareness of hearing-loss problems, compensation of various sorts, and the masculinity-femininity dimension mentioned above. Industrial medical officers, it was felt, would see audiometry in terms of its centrality or otherwise to hearing conservation, litigation, education, and its economic aspects. These expectations were used as the framework for the construction of the various tests.

4.3.10. The Naming of Factors

Such expectations can affect the naming of extracted factors, as can the other points discussed earlier. The naming of factors is the most contentious area of factor analysis and the point at which most criticisms against it are focussed. Factor naming is also referred to as interpreting factors and the terms are used synonymously. However, naming is much more accurate as interpretation should really refer to evaluating the psychological importance of factors with the name attached to each factor being used as a convenient label to aid in this evaluation. There is no reason why factors should not be called Factor 1, Factor 2, Factor 3, and so on. Indeed this is how the computer labels them. However, a semantic label or name attached to each factor helps evaluation enormously. But such labels should not be thought of as sacrosanct because a dozen separate researchers may place a dozen different names upon the same factors. This is where many of the critics of factor analysis aim their attentions. The names, though, are not important so long as the essence, the meaning, the implications of the factors unearthed for the research problem, are not obscured. Thus our dozen researchers with their dozen names may all reach but one conclusion. This is the aim of factor analytic research.

A factor is named by ranking all the items which load significantly on it in order of the absolute size of their loading (see Appendix 3) and then trying to identify the psychological attribute that these items share in common to greater or lesser extents according to the magnitude of their loadings. This is not an easy task and sometimes two independent factors may seem to be representing the same psychological dimension, the subtle difference between them revealing itself only when the factors are laid side by side and inspected together. The greater the loading of an item on a factor the more weight is placed upon it in naming the factor. A common mistake that is made here is to assume that the magnitude of a loading in some way reflects the extent of agreement of respondents with the factor as expressed by that particular item. A related mistake is that a positive loading represents agreement while a negative loading represents disagreement. It will be recalled from earlier in this explanation of factor analysis that factor loadings are correlations between factors and test items and so a factor loading is simply a measure of association between factors and test items with the sign simply representing relative direction of association. It is quite permissible to reverse all the signs on a factor as this in no way affects the interpretation of it. Indeed such a procedure is often used to make factors easier for factor analytic researchers to visualise in their own minds.

4.4 Summary of Chapter 4

1. The four techniques to be used for testing the research hypotheses were described. One of these techniques consisted of two attitude questionnaires to be administered to workers, one concerned with audiometry and one concerned with personal hearing protectors. The samples of workers were, if possible, to be drawn from:-

(a) factories whose hearing conservation programmes included both audiometry and the issue of personal hearing protectors;

(b) factories whose hearing conservation programmes included neither audiometry nor personal hearing protectors;

(c) factories whose hearing conservation programmes included personal hearing protectors but not audiometry;

(d) factories whose hearing conservation programmes included audiometry but not personal hearing protectors.

Another of these techniques involved a postal questionnaire sent to industrial medical officers who were members of the Society of Occupational Medicine or the British Occupational Hygiene Society. The questionnaire consisted of three parts, the first and major part concerned with various aspects of any hearing conservation programmes with which the respondent was involved, the second and most minor part concerned with personal details of the respondent, and the last part being an attitude questionnaire concerned with industrial audiometry.

The third technique involved visiting factories in which personal hearing protectors were issued and performing surveys to ascertain the proportion of the working population, to which such protectors were issued, were actually wearing them. Factories which carried out audiometric testing were to be compared with factories which did not.

The fourth technique was that of interviews carried out with key personnel concerned with the preservation of workers' hearing in designated noisy areas. Such personnel were to include industrial medical officers, industrial safety officers, and others of a managerial or technical sort. The questions asked in the interviews were to be standardised. The intention was to compare factories performing audiometry with factories not.

Which technique was used to test which hypotheses was summarised.

2. The historical development of the research strategy was described, including practical problems that needed to be overcome. A description was given of both Thurstone scaling and Likert scaling with an explanation of why the latter was eventually chosen after the former was originally seen as preferable.

3. Factor analysis was described in some detail in terms of what it does, how it is generally used, and some of the problems and misconceptions surrounding it.

The objective of the practical aspect of the thesis is to derive testable hypotheses from the surveyed research and opinions concerning industrial audiometry. Two types of hypothesis will be generated:-

(a) hypotheses derived directly from the literature (the main hypotheses); and

(b) hypotheses drawn by inference (the subsidiary hypotheses).

The hypotheses will form the anchor point for designing a piece of research which will generate the information necessary in order to meet the objectives outlined (with the exception, of course, of the literature review).

FIGURE I: Resumé of which hypothesis was being tested by which technique

TECHNIQUES	MAIN HYPOTHESES			SUBSIDIARY HYPOTHESES					
	1	2	3	1	2	3	4	5	6
THE TWO WORKERS QUESTIONNAIRES	X	X		X	X				
THE INDUSTRIAL MEDICAL OFFICERS QUESTIONNAIRE			X			X	X	X	X
THE SURVEYS OF PERSONAL HEARING PROTECTOR USAGE	X								
THE DETAILED INTERVIEWS WITH KEY PERSONNEL IN COMPANY HEARING CONSERVATION PROGRAMMES						X			

CHAPTER 5

THE RESEARCH METHOD

5.1 Medical Officer's Questionnaire

5.1.1 Analysis of the Questionnaire

For the purposes of this analysis, respondents to the questionnaire were divided into three groups; those whose employers performed audiometry, those whose employers did not, and those employed by firms some of which performed audiometry and some of which did not. These three groups were called "Yeses", "Noes" and "Somes" respectively. The questionnaires were analysed using the SPSS Cross-tabulation Package on the ICL 1904a Computer at Aston University. This package produces two-way tabulations of selected variables and performs a Chi-square analysis on each one. The analyses were performed three times, each time with one of the respondent groups left out, that is, the analyses performed were of Yeses X Noes, Yeses X Somes, and Noes X Somes. On question 12 it was discovered that only a proportion of respondents had answered the question as had been intended. Others had answered it by ranking the question items in order of priority while a third group had simply indicated whether they would or would not carry out the programme suggested given the budget constraints set out before them. This question was thus analysed separately for each of the three different response types. The questionnaire form is included for reference in Appendix 1 but for the sake of brevity only those questions or items which produced statistically significant ($p < .05$) differences between the two respondent groups being analysed will be included in this section.

In answer to the attitude part of the questionnaire, respondents were asked to indicate their strength of agreement or disagreement with each item on a five-point Likert scale ranging from "strongly agree" through "agree", "uncertain", "disagree" to "strongly disagree". During subsequent analysis, a value of five was allotted to "strongly agree", four to "agree", three to "uncertain", two to "disagree" and one to "strongly disagree".

This part of the questionnaire was analysed separately for each of the three groups by means of the SPSS Factor Analysis package available on the Aston University ICL 1940a computer. Each was subjected to a principal components analysis using an iterative procedure and then rotated according to three separate criteria, Varimax, Quartimax and Equimax. Only factors with eigenvalues of one or more were extracted and, because of the uncertainty surrounding the estimation of error variance in factor analysis (Child 1970) only items with factor loadings significant at the .01 level using the Burt-Banks formula (Burt and Banks 1947) were accepted as representing a particular factor and a minimum of three significant loadings was taken as necessary for the identification of a factor. Occasionally, only two items loaded significantly at the .01 level on a particular factor while factors lower in the order of extraction met all the criteria of acceptability outlined above. In such cases, items loading significantly at the .05 level were accepted as representing the factor in order to aid in interpretation but they were not included in the computations for obtaining factor scale scores. These computations are described below.

5.1.2 Calculation of the Factor Scale Scores

The mean Likert scale score for each item in the sample was calculated. The score for each item in a particular factor significant at the .01 level was multiplied by the appropriate factor loading. For each factor the mean of these values was obtained and then converted to a value on a five-point Likert-type scale such that a value of five would represent strong agreement with the factor as named, a value of one would represent strong disagreement with the factor as named and a value of three would represent an uncertain viewpoint. Unlike the original discrete five-point Likert scale, the derived factor scale scores vary continuously between one and five. This method is based upon that used by Eysenck (1953).

5.2 Workers' Questionnaires

5.2.1 Resumé of the Construction of the Questionnaires

There were two questionnaires, one intended to measure attitudes towards audiometry and the other attitudes towards hearing protectors. For each questionnaire a pool of items related to the concept under study was constructed. The audiometry pool consisted of 131 items, the hearing protectors pool of 147. Repetitions or particularly vague items were then excluded, thereby reducing the audiometry pool to 34 items and the hearing protectors pool to 47. These pools were then submitted to a panel of six workers from a local industrial concern for comments on the appropriateness and intelligibility of the items. The items drawing the most unfavourable comments were then excluded. Thus the final questionnaires consisted of 27 and 32 items for the audiometry and hearing protectors questionnaires respectively and are reproduced in Appendix 1.

5.2.2. The Selection of the Companies Providing the Worker Sample

The questionnaires were used in three companies; one performing audiometry and providing personal hearing protectors (Firm 1), one doing neither of these things (Firm 2), and one providing personal hearing protectors but not performing audiometry (Firm 3). A company performing audiometry but not providing personal hearing protectors could not be found.

The method employed to obtain the services of these three companies involved personal contacts with two of the three main suppliers of audiometers in the United Kingdom, a personal contact within H.M. Factory Inspectorate, and the author's own interviews with industrial medical officers and safety officers, all of whom were used to furnish names of companies which might be suitable for the present research. A list of 16 companies (eight performing audiometry and eight not) was thus obtained, selected in as random a fashion as possible in the circumstances, which agreed to discuss the research request. 13 eventually declined to take part. There were three types of reason given for this refusal:

(a) management concern over the effect of the questionnaires upon industrial relations - "it might stir them up" (the workers);

(b) organisational difficulties;

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(c) the refusal of some internal committee or management decision-maker, with which or with whom the author was not dealing directly, to sanction the research request.

Three companies which co-operated willingly were thus left. The question of non-co-operation will be dealt with more fully later.

5.2.3 The Selection of the Worker Samples

The procedure used in each firm for selecting workers for inclusion in the respondent samples was for a visit to be made to the factory (accompanied, at all times, by the safety officer or someone to whom the task was delegated) and select noisy areas from which to draw respondents. In each case, it was preferable to use all the workers in the areas selected but internal protocol obliged one to deal directly with the managers of the areas concerned who decided the extent to which the research goals and their production goals or whatever were compatible. Therefore there was no choice but to be satisfied with a proportion of the available workforce. However, the author is confident that no systematic sampling bias occurred as he had little control over the selection of individual workers while those who did were naive as to the precise nature of the research. The selection procedure was essentially a double-blind one and the fact that only one respondent out of the total of 118 used was female is a reflection of the heavy male bias amongst workers exposed to noise rather than of a sex-bias artificially injected.

In Firm 1 the sample consisted of 52 respondents (all male) while in Firm 2 the sample consisted of 51 respondents (50 male and one female). In Firm 3 it was hoped for 70 respondents (all male) but a breakdown in industrial relations to be described below prevented more than 15 questionnaires from being returned. Questionnaires were given out by departmental managers and shop stewards after negotiation with them and then returned by the same route.

5.2.4. Interference Resulting from a Breakdown in Industrial Relations at Firm 3

The breakdown in industrial relations occurred as a result in the failure of negotiations between management and trades unions over the renewal of an agreement between the two parties. The trades unions did not resort to action as drastic as work stoppages, but instead instituted a policy of non-co-operation with management or anything perceived as being concerned with management. Unfortunately, the questionnaires were interpreted in this way. It was only possible to contact the employees in the sample via management representatives and they would not contact the particular employees directly because they regarded the overall situation as delicate. Thus they made approaches to trades union representatives who simply maintained the matter at a very low priority as part of their policy of non-co-operation. Hence only 15 returns.

5.2.5. Instructions to Respondents

Respondents were asked to indicate their strength of agreement or disagreement with each item on a five-point Likert scale ranging from "strongly agree" through "agree", "uncertain", "disagree" to "strongly disagree". During subsequent analysis, a value of five was allotted to "strongly agree" and one was allotted to "strongly disagree", the intervening points being valued appropriately.

5.2.6. Analysis of the Questionnaires

The audiometry questionnaires were analysed using the SPSS Factor Analysis package available on the University of Aston in Birmingham's ICL 1904a computer in exactly the same way as was the attitude part of the medical officers' questionnaire. Unfortunately, as was mentioned earlier, the limitations of the SPSS Factor Analysis package available on the Aston University computer were more strict than those outlined in the general manual for the package. Specifically, only 29 variables (questionnaire items) could be handled in any analysis at maximum while the manual gave a limitation of 66 variables. As the hearing protectors questionnaire contained 32 items, this SPSS package could not handle it. Instead the University of Aston in Birmingham application programme UAAP UO24 was used. This package could handle any number of variables but in addition to Principal Components analysis produced only Varimax and Promax rotations instead of the Varimax, Quartimax and Equimax rotations produced by the SPSS package. Thus there are differences in the analysis of the two questionnaires. (The purpose of performing a number of different factor rotations in addition to the Principal Components analysis was to check the robustness of the factors, that is to say, if a factor can be identified under a variety of different types of analysis then there is reason to accept it as real and not spurious. This was discussed earlier.

The more forms of analysis that are performed, the more rigorous is the test of robustness, but in this case the difference between three and four forms of analysis are unlikely to adversely affect the strength of conclusions that may be drawn. Also the types of factor rotation should not affect the principle involved). The criteria applied to the factors extracted in the hearing protectors questionnaire and the derivation of factor scale scores were exactly the same as for the audiometry questionnaire and the attitude part of the medical officers' questionnaire.

5.3 The Hearing Protector Surveys

Permission was obtained from eight companies, four performing audiometry and four not, to walk around their noisy areas and count the number of workers wearing hearing protectors, whether earmuffs or earplugs. These eight companies came from amongst the 16 referred to earlier, that is they were the co-operating members of an essentially random sample of companies with a noise problem. On each walk-around, it was necessary to be accompanied by a member of the company management - commonly the safety officer - and so this meant that only one inspection could practicably be made in each case. (This point has been discussed earlier). No warning of inspection was given either to workers or their immediate supervisors. However, as the data of interest were percentage usage and non-usage, the sampling distribution is binomial which approximates a normal sampling distribution closely enough for confidence limits to be calculated, the formula being:-

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$$y = \pm S\sqrt{\frac{pq}{n}}$$

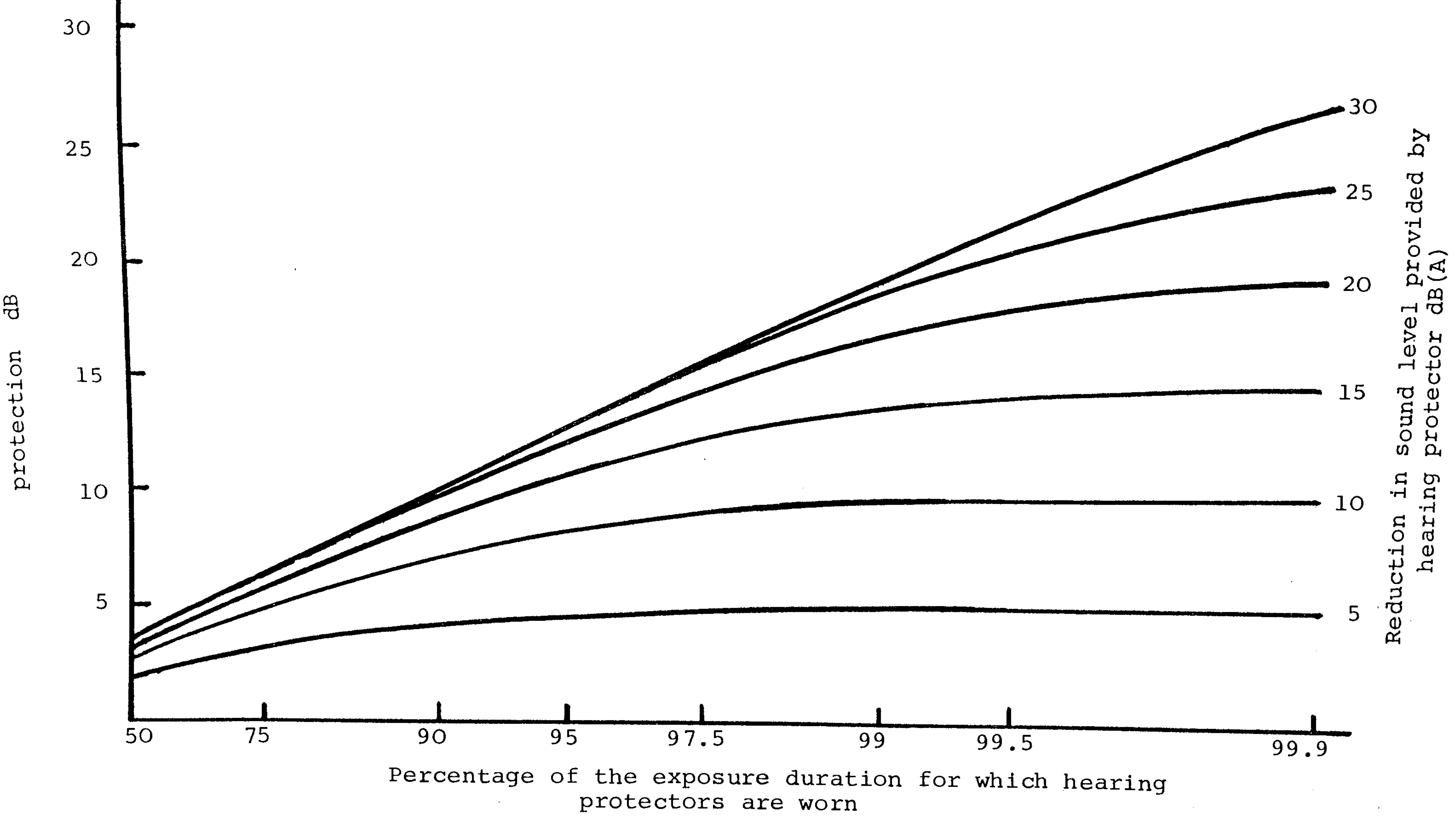
where y is the confidence limit to be calculated, S is the number of standard deviations from the mean representing the level of statistical significance adopted, p and q are the percentages of usage and non-usage, and n is the sample size.

5.3.1 The Role of "Time Worn" in Assessing Personal Hearing Protector Usage

Else (1976b)has shown that the effective protection afforded by hearing protectors, in terms of amount of sound energy received by the ear during the course of the working day, is a function of both the attenuation of the hearing protectors and the percentage of the noise-exposure duration for which they are worn (see figure 1). Thus, in order to survey a programme of hearing protection adequately, it is necessary to find out not only how many hearing protectors are being worn but whether they are being worn for the time necessary to give adequate protection. This is vital if the information sought concerns the effectiveness of the programme as a protector of hearing. However this degree of precision was not necessary for the present research, the aim of which was to see if a link existed between audiometry and hearing protector usage. The adequacy of the usage becomes important enough to justify the extra effort involved in investigating it after such a link has been found.

FIGURE 2

Protection Provided by Hearing Protectors as a Function of the Reduction in Sound Level they provide and the Percentage of the Exposure Duration for which They are Worn (Else 1976b)



5.4 The Detailed Interview Part of the Study

Five companies permitted interviews of their medical officer and/or safety officer and certain managerial and technical staff about the action taken by those companies against noise-induced hearing-loss. Two companies included audiometry in their hearingconservation programmes while the other three did not. The answers to 20 general questions were sought from each company and a further 17 specific questions were put to the companies performing audiometry. The general questions were:-

1. What noise levels exist?
2. How many workers are employed by the Company?
3. How many workers are there in areas of 90 dB(A) ENCL or more?
4. What types of hearing protectors are provided?
5. What instructions are given to people on the use of hearing protectors?
6. How do workers obtain hearing protectors?
7. Are there any estimates of factory temperatures available?
8. Are there similar estimates of humidity?
9. Is dust of any sort present?
10. What types of work are performed in the factories?
11. What other protective equipment are workers required to wear?
12. What regulations are currently in force?
13. Are the occupational physician, the safety officer and the industrial hygienist full-time or part-time?
14. How big is the Medical Department in terms of staff?
15. How much money is allotted to the Medical Department?
16. What sort of campaign is used to persuade workers to wear hearing protectors?

17. Do supervisory staff wear hearing protectors in areas of 90 dB(A) or more?

18. Do visitors wear hearing protectors in areas of 90 dB(A) or more?

19. Is the wearing of hearing protectors a condition of employment? If so, do workers sign a declaration? Also how is it enforced?

20. Are there any common law claims outstanding against the company?

The 17 specific questions related to audiometry. They were:

1. Is the audiometry manual or automatic?
2. Is the audiometry serial and, if so, at what time intervals.
3. If referrals to NHS E.N.T. Departments are made, what criteria are used for such referrals?
4. If the audiometry is used for baseline purposes, how many audiograms are taken?
5. Is audiometry performed pre-employment?
6. Is audiometry performed pre-placement?
7. Is audiometry performed post-employment or post-placement?
8. What frequencies are tested?
9. What arrangements are made for dealing with temporary threshold shift?
10. Are testees informed of results? If so, by whom?
11. Are testees advised to wear hearing protectors by the occupational physician or by the audiometrician?
12. When was the audiometry first started?
13. Who initiated it and why was it introduced?
14. The number of people tested (in total and per day)
15. What criteria are used for selecting people for testing?

16. Is the audiometry performed by the firm or by outside bodies?
17. What are the results of the audiometry programme used for?

These questions were not administered as a formal questionnaire but, instead, were used as a framework around which to structure the interviews.

5.5 Summary of Chapter 5

1. The analysis of the medical officers questionnaire was described.

2. The administration and analysis of the workers' questionnaire was described.

3. The conduct of the personal hearing protector use surveys was described. Also the percentage of time for which personal hearing protectors are worn was discussed.

4. The questions used in the detailed interview part of the study were outlined. There were twenty general questions asked of the interviewees from all five companies who agreed to take part in the research, and seventeen additional questions specific to the use of audiometry asked of interviewees from the two companies which included audiometry in their hearing conservation programmes.

SECTION III: RESULTS

CHAPTER 6

DESCRIPTION OF RESULTS

6.1 Medical Officers' Questionnaire

Magnitude of the Response to the Questionnaire

Out of 895 questionnaires sent out, 451 were returned,* a response rate of 50.39%. (This may not seem a very good response and indeed it is not a high one compared with what is possible (see Scott 1961). However for a complex mail survey a response rate of approximately 40 to 60% is what would often be expected (Oppenheim 1966) and so in this context 50.39% is reasonable.) Of these 451, 171 indicated that they were not practising occupational medicine. The remaining 280 formed the sample to be analysed. These 280 consisted of 130 Yeses, 115 Noes and 35 Somes.

The Analysis

Three separate analyses were produced, Yeses X Noes, Yeses X Somes and Noes X Somes. Each of these analyses is presented in terms of the statistical differences between the particular groups of respondents on individual items. Two forms of presentation are used in each case, first a verbal description of these differences and then a presentation in tabular form. In each instance the same information is given.

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* The initial response consisted of 379 returns. A reminder letter was sent out 2 weeks after the initial mailing-shot and produced a further 72 returns, an increase of 19%. A second reminder letter would therefore have been expected to produce approximately 14 more returns (see Scott 1961), too few to justify the effort involved. Thus no more reminders were sent.

6.1.1. Yeses X Noes Analysis

6.1.1.1.
General Results

There were no significant differences between these groups as regards ranking the reasons why respondents felt other people performed audiometry and there were no significant differences between their rankings of occupationally originated injuries and disorders. There were also no significant differences between the two groups as regards whether or not respondents conducted research in occupational health, year of qualification or sex of respondent. However, significant differences did exist. Yeses were much more likely to be full-time than Noes. More Yeses said it was their company's policy to attempt to quieten noisy machinery and to attempt to control noise at the machinery and plant design stage. More Yeses than Noes said it was their company's policy to provide earmuffs for employees required to work in noisy areas. More Yeses than Noes said that the industry which employed them either had been or still was involved in common law claims for alleged occupational hearing-loss.

6.1.1.2
Respondents Whose Employers Provided Personal Hearing Protectors

Of those respondents whose employers provided hearing protectors, more Yeses than Noes said that the programme designed to encourage their use employed posters, talks given by medical officers, talks given by nursing staff, films and various other means to this end. More Noes than Yeses worked in no other field than occupational health and more Noes than Yeses worked in general practice.

Noes were, on average, older than Yeses.

6.1.1.3
Responses to the Attitude Part of the Questionnaire

On the attitude questionnaire there were significant differences between the two groups on 14 of the 27 items. Yeses more than Noes agreed that "industrial audiometry is a useful diagnostic tool", that "audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing", that "audiometry and noise control are inseparable", that "where a firm has a programme of medical screening audiometry should be a part of that programme", that " audiometry encourages the use of hearing protectors by workers", and that "audiometry is relatively inexpensive". Noes more than Yeses agreed that "audiometry is not advisable in an industrial situation", that "audiometry has no effect on industrial relations", that "audiometry is an expensive toy for occupational physicians to play with", that "money spent on audiometry would be better spent on noise control", that "the value of audiometry in industry is unestablished", that "audiometry is an adjunct to a hearing conservation programme and no more", and that"not enough is known about industrial audiometry to make statements about its usefulness". Both disagreed that "audiometry is basically anti-worker" but Yeses did so more strongly.

6.1.1.4
Responses to the Hypothetical Budget Question

On question 12, the hypothetical budget question, no significant differences existed amongst those respondents who had ranked the options in terms of priority. Amongst those who had answered the question as intended by the instructions (i.e. divided each allotted budget between the options) only two significant differences existed - both in the £5,000 budget section. These indicated that Noes would advise spending of more money on quietening existing plant and machinery than would Yeses while Yeses would advise the spending of more money on audiometry than would Noes. Amongst those respondents who answered on a Yes-No basis, i.e. they either would or would not spend money on the option in question given the budget in question, there were no significant differences on the £5,000 budget. On the £25,000 budget there were no significant differences on the noise control options (options a, b and c) but on each of the remaining options more Yeses than Noes indicated that they would spend money. On the £100,000 budget, more Yeses than Noes indicated that they would spend money on all of the options except option f (noise-hazard education programmes) upon which there was no significant difference.

TABLE 13 Table of statistically significant differences between industrial medical officers performing audiometry (Yeses) and those not (Noes). Results expressed as a function of questions asked on the questionnaire.

GENERAL SECTION

	DIRECTION OF DIFFERENCE (IF SIGNIFICANT)	LEVEL OF SIGNIFICANCE
Are you engaged in Occupational Medicine		
(a) full-time?	Yeses > Noes	.005
(b) part-time?	Noes > Yeses	.005
If part-time, please state the number of sessions per week	-	n.s.
and the number of hours per session	-	n.s.
For which of the reasons listed below do you think audiometry is performed by other people in industry? Please rank them in order of importance.		
(a) To screen out individuals for further investigation	-	n.s.
(b) To provide an occasion for persuading reluctant workers to wear hearing protectors which have been provided	-	n.s.
(c) To assist in the job-placement of individuals who possess a hearing-loss	-	n.s.
(d) To provide a record of changes in an individual's hearing level	-	n.s.
(e) To detect individuals who may be an accident risk either to themselves or to others because of poor hearing ability	-	n.s.
(f) To detect noise-susceptible individuals	-	n.s.
(g) To practice health surveillance	-	n.s.
(h) To provide a baseline for later comparisons	-	n.s.
(i) To provide biological monitoring	-	n.s.
(j) To provide information which may be useful in any subsequent litigation for alleged noise-induced hearing-loss	-	n.s.
(k) As an essential tool of preventive medicine	-	n.s.
(l) To reduce the strain upon NHS ear, nose and throat departments	-	n.s.
(m) Any other reason(s) (please specify)	-	n.s.

Continued.....

TABLE 13 (continued)

	DIRECTION OF DIFFERENCE (IF SIGNIFICANT)	LEVEL OF SIGNIFICANCE
In the industries or organisations in which you are employed, is it the policy to:		
(a) attempt to quieten existing noisy machinery?	Yeses > Noes	.05
(b) attempt to control noise at the machinery and plant design stage?	Yeses > Noes	.05
(c) insist upon noise-limiting requirements when purchasing new plant and machinery?	-	n.s.
(d) provide for employees required to work in "noisy" areas:		
(i) ear muffs?	Yeses > Noes	.005
(ii) ear plugs?	-	n.s.
(e) control administratively the amount of time spent by employees in "noisy" areas?	-	n.s.
Have any of the industry(ies) in which you are employed:		
(a) been involved in common law claims for alleged occupational hearing-loss whether these were settled in or out of court?	Yeses > Noes	.005
(b) any common law claims for alleged occupational hearing loss outstanding at the moment?	Yeses > Noes	.01
Below is a very broad classification of injuries and disorders which can have an occupational origin. Could you please rank them in order of priority as regards their prevention by placing a "1" opposite that item, the prevention of which you feel should have top priority, a "2" opposite the highest priority amongst the remaining items, and so on?		
(a) Respiratory disorders	-	n.s.
(b) Minor accidental injuries	-	n.s.
(c) Occupational cancer	-	n.s.
(d) Damage to eyesight	-	n.s.
(e) Major accidental injuries	-	n.s.
(f) Noise-induced hearing	-	n.s.
(g) Fire and explosion injuries	-	n.s.
(h) Poisoning by toxic metals (as distinct from excessive absorption)	-	n.s.
(i) Dermatitis	-	n.s.

continued.....

TABLE 13 (continued)

	DIRECTION OF DIFFERENCE (IF SIGNIFICANT)	LEVEL OF SIGNIFICANCE
If hearing protectors of any kind are provided by the industry(ies) in which you work, does the programme designed to encourage their use employ:		
(a) Posters	Yeses > Noes	.01
(b) Talks given by medical officers	Yeses > Noes	.001
(c) Talks given by nursing staff	Yeses > Noes	.01
(d) Talks given by the safety officer or his staff	-	n.s.
(e) Talks given by managers	-	n.s.
(f) Talks given by workers' representatives	-	n.s.
(g) Advisory pamphlets	-	n.s.
(h) Films	Yeses > Noes	.001
(i) Advice given by medical officers at audiometric testing sessions	Yeses > Noes	.001
(j) Advice given by nursing staff at audiometric testing sessions	Yeses > Noes	.001
(k) Other means (please specify)	Yeses > Noes	.01
Do you conduct research in occupational health?	-	n.s.
Which other medical fields do you currently work in?		
(a) None	Noes > Yeses	.025
(b) General Practice	Noes > Yeses	.001
(c) University	-	n.s.
(d) Hospital	-	n.s.
(e) Other (please specify)	-	n.s.
Pleasestate the year in which you qualified	-	n.s.
Age	Noes > Yeses	.025
Sex	-	n.s.

HYPOTHETICAL BUDGET QUESTION

This is a hypothetical question. If you were to be asked to advise a company employing 1,500 people on how to spend a budget allocated to tackling the problem of noise-induced deafness, how would you advise the company to apportion it amongst the options listed below if the budget were (i) £5,000, (ii) £25,000, (iii) £100,000?

RESPONDENTS WHO REPLIED EITHER YES OR NO TO EACH ITEM

	£5,000	£25,000	£100,000
(a) Quietening existing plant and machinery	n.s.	n.s.	Yeses > Noes .005
(b) Development of methods of quietening existing plant and machinery	n.s.	n.s.	Yeses > Noes .05
(c) Designing quieter machines	n.s.	n.s.	Yeses > Noes .025
(d) Carrying out noise surveys	n.s.	Yeses > Noes .005	Yeses > Noes .025
(e) Providing hearing protectors	n.s.	Yeses > Noes .005	Yeses > Noes .05
(f) Noise-hazard education programmes	n.s.	Yeses > Noes .01	n.s.
(g) Encouraging the use of hearing protectors provided (ie. supervision, posters, training courses, etc.)	n.s.	Yeses > Noes .025	Yeses > Noes .05
(h) Audiometry	n.s.	Yeses > Noes .001	Yeses > Noes .025

continued.....

RESPONDENTS WHO USED RANKINGS ONLY

	£5,000	£25,000	£100,000
(a) Quietening existing plant and machinery	n.s.	n.s.	n.s.
(b) Development of methods of quietening existing plant and machinery	n.s.	n.s.	n.s.
(c) Designing quieter machines	n.s.	n.s.	n.s.
(d) Carrying out noise surveys	n.s.	n.s.	n.s.
(e) Providing hearing protectors	n.s.	n.s.	n.s.
(f) Noise-hazard education programmes	n.s.	n.s.	n.s.
(g) Encouraging the use of hearing protectors provided (ie.supervision,posters,training courses, etc.)	n.s.	n.s.	n.s.
(h) Audiometry	n.s.	n.s.	n.s.

RESPONDENTS APPORTIONING MONEY AS INTENDED BY THE INSTRUCTIONS

	£5,000	£25,000	£100,000
(a) Quietening existing plant and machinery	Noes Yeses .025	n.s.	n.s.
(b) Development of methods of quietening existing plant and machinery	n.s.	n.s.	n.s.
(c) Designing quieter machines	n.s.	n.s.	n.s.
(d) Carrying out noise surveys	n.s.	n.s.	n.s.
(e) Providing hearing protectors	n.s.	n.s.	n.s.
(f) Noise-hazard education programmes	n.s.	n.s.	n.s.
(g) Encouraging the use of hearing protectors provided (ie supervision,posters,training courses, etc.	n.s.	n.s.	n.s.
(h) Audiometry	Yeses > Noes .025	n.s.	n.s.

ATTITUDE PART OF THE QUESTIONNAIRE

	Group Expressing Higher Mean Level of Agreement with Statement (if a Significant Difference exists between Groups)	Level of Significance
1. Industrial audiometry is a useful diagnostic tool	Yeses	.05
2. Audiometry is an essential part of any hearing conservation programme	-	n.s.
3. Assessing a worker's hearing ability is not necessary in order to protect it	-	n.s.
4. A higher priority should be given to testing the hearing abilities of workers than is given at present	-	n.s.
5. Audiometry is not advisable in an industrial situation	Noes	.005
6. Audiometry has no effect on industrial relations	Noes	.05
7. Audiometry is an expensive toy for occupational physicians to play with	Noes	.005
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry	-	n.s.
9. Industrial audiometry is basically anti-worker	Noes	.001

continued.....

	Group Expressing Higher Mean Level of Agreement With Statement (if a Significant Difference exists between Groups)	Level of Significance
10. Money spent on audiometry would be better spent on noise control	Noes	.001
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing	Yeses	.025
12. Audiometry and noise control are inseparable	Yeses	.025
13. Firms should be compelled by law to periodically test the hearing of their employees	-	n.s.
14. Workers regard audiometry as evidence of their employer's concern for their welfare	-	n.s.
15. Audiometry can never prevent occupational deafness	-	n.s.
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme	Yeses	.001
17. The value of audiometry in industry is unestablished	Noes	.005
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss	-	n.s.

	Group Expressing Higher Mean Level of Agreement with Statement (if a Significant Difference exists between Groups)	Level of Significance
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise-induced hearing-loss	-	n.s.
20. Audiometry is an adjunct to a hearing conservation programme and no more	Noes	.025
21. Audiometry encourages the use of hearing protectors by workers	Yeses	.005
22. Audiometry encourages managements to take an interest in the problem of noise at work	-	n.s.
23. Not enough is known about industrial audiometry to make statements about its usefulness	Noes	.05
24. Audiometry and hearing protection are inseparable	-	n.s.
25. Not many people in industry care very much about audiometry	-	n.s.
26. No matter what people say, testing the hearing of workers can't do anyone any harm	-	n.s.
27. Audiometry is relatively inexpensive	Yeses	.001

6.1.2 Yeses X Somes Analysis

6.1.2.1
General Results: Group Similarities

There were no significant differences between these two groups of respondents in terms of why they did audiometry, the sections of the working populations for which they were responsible upon which it was employed, the reasons that they thought other people performed audiometry for, whether or not the industries that employed them had been or still were involved in common law claims for alleged occupational deafness, the priority given to preventing the occupational injuries and disorders named, the methods used to persuade people to wear hearing protection, with one exception, research in occupational health, year of qualification, age and sex. In fact the two groups were very similar.

6.1.2.2.
General Results: Group Differences

However, there were significant differences. Yeses were much more likely to be full-time than Somes. This is not really surprising. More Yeses than Somes indicated that it was the policy to attempt to quieten existing noisy machinery in all of the industries that employed them. More Yeses than Somes indicated that this was so in none of their industries while more Somes than Yeses indicated that it was so in some of their industries. A similar pattern emerged as regards providing earmuffs to people required to work in noisy areas. Yeses were more likely to employ various means not named on the questionnaire to persuade people in noisy areas to wear hearing protectors provided (the one exception referred to earlier). More Yeses than Somes worked in no other medical field than industrial medicine while more Somes than Yeses worked in general practice.

6.1.2.3
Responses to the Attitude Part of the Questionnaire

On the attitude questionnaire significant differences existed on only four of the 27 statements. More Yeses than Somes agreed that "where a firm has a programme of medical screening audiometry should be a part of that programme". More Somes than Yeses agreed that "audiometry is not advisable in an industrial situation", that "money spent on audiometry would be better spent on noise control", and that "the value of audiometry in industry is unestablished".

6.1.2.4.
Responses to the Hypothetical Budget Question

On the hypothetical budget question only a few significant differences existed. Among the respondents who ranked the options only one significant difference existed - on the £5,000 budget section where Yeses ranked audiometry slightly more highly than did Somes. Amongst those respondents who responded in terms of Yes and No only there was a solitary significant difference on the £5,000 budget section, namely, more Somes than Yeses said they would spend money on developing methods of quietening existing plant and machinery. Amongst the respondents who replied as intended by the instructions, significant differences existed only on the £5,000 budget section. Somes indicated that they would spend more money on noise-hazard education programmes than would Yeses and also more money on encouraging the use of hearing protectors than would Yeses.

TABLE 14 Table of statistically significant differences between medical officers performing audiometry in some factories but not in others (Somes) and medical officers performing audiometry in all their factories (Yeses). Results expressed as a function of questions asked on the questionnaire

GENERAL SECTION

	DIRECTION OF DIFFERENCE (IF SIGNIFICANT)	LEVEL OF SIGNIFICANCE
Are you engaged in Occupational Medicine		
(a) full-time?	Yeses > Somes	.001
(b) part-time?	-	n.s.
If part-time, please state the number of sessions per week	-	n.s.
and the number of hours per session	-	n.s.
For which of the reasons listed below do you think audiometry is performed by other people in industry? Please rank them in order of importance.		
(a) To screen out individuals for further investigation	-	n.s.
(b) To provide an occasion for persuading reluctant workers to wear hearing protectors which have been provided	-	n.s.
(c) To assist in the job-placement of individuals who possess a hearing-loss	-	n.s.
(d) To provide a record of changes in an individual's hearing level	-	n.s.
(e) To detect individuals who may be an accident risk either to themselves or to others because of poor hearing ability	-	n.s.
(f) To detect noise-susceptible individuals	-	n.s.
(g) To practice health surveillance	-	n.s.
(h) To provide a baseline for later comparisons	-	n.s.
(i) To provide biological monitoring	-	n.s.
(j) To provide information which may be useful in any subsequent litigation for alleged noise-induced hearing-loss	-	n.s.
(k) As an essential tool of preventive medicine	-	n.s.
(l) To reduce the strain upon NHS ear, nose and throat departments	-	n.s.
(m) Any other reason(s) (please specify)	-	n.s.

Continued.....

TABLE 14 (continued)

	DIRECTION OF DIFFERENCE (IF SIGNIFICANT)	LEVEL OF SIGNIFICANCE
In the industries or organisations in which you are employed, is it the policy to:		
(a) attempt to quieten existing noisy machinery?	-	n.s.
(b) attempt to control noise at the machinery and plant design stage?	Interaction	.005
(c) insist upon noise-limiting requirements when purchasing new plant and machinery?	-	n.s.
(d) provide for employees required to work in "noisy" areas:		
(i) ear muffs?	Interaction	.05
(ii) ear plugs?	-	n.s.
(e) control administratively the amount of time spent by employees in "noisy" areas?	-	n.s.
Have any of the industry(ies) in which you are employed:		
(a) been involved in common law claims for alleged occupational hearing-loss whether these were settled in or out of court?	-	n.s.
(b) any common law claims for alleged occupational hearing loss outstanding at the moment?	-	n.s.
Below is a very broad classification of injuries and disorders which can have an occupational origin. Could you please rank them in order of priority as regards their prevention by placing a "1" opposite that item, the prevention of which you feel should have top priority, a "2" opposite the highest priority amongst the remaining items, and so on?		
(a) Respiratory disorders	-	n.s.
(b) Minor accidental injuries	-	n.s.
(c) Occupational cancer	-	n.s.
(d) Damage to eyesight	-	n.s.
(e) Major accidental injuries	-	n.s.
(f) Noise-induced hearing	-	n.s.
(g) Fire and explosion injuries	-	n.s.
(h) Poisoning by toxic metals (as distinct from excessive absorption)	-	n.s.
(i) Dermatitis	-	n.s.

continued.....

TABLE 14 (continued)

	DIRECTION OF DIFFERENCE (IF SIGNIFICANT)	LEVEL OF SIGNIFICANCE
If hearing protectors of any kind are provided by the industry(ies) in which you work, does the programme designed to encourage their use employ:		
(a) Posters	-	n.s.
(b) Talks given by medical officers	-	n.s.
(c) Talks given by nursing staff	-	n.s.
(d) Talks given by the safety officer or his staff	-	n.s.
(e) Talks given by managers	-	n.s.
(f) Talks given by workers' representatives	-	n.s.
(g) Advisory pamphlets	-	n.s.
(h) Films	-	n.s.
(i) Advice given by medical officers at audiometric testing sessions	-	n.s.
(j) Advice given by nursing staff at audiometric testing sessions	-	n.s.
(k) Other means (please specify)	Interaction	.025
Do you conduct research in occupational health?	-	n.s.
Which other medical fields do you currently work in?		
(a) None	Yeses > Somes	.05
(b) General Practice	Somes > Yeses	.001
(c) University	-	n.s.
(d) Hospital	-	n.s.
(e) Other (please specify)	-	n.s.
Please state the year in which you qualified	-	n.s.
Age	-	n.s.
Sex	-	n.s.

HYPOTHETICAL BUDGET QUESTION

This is a hypothetical question. If you were to be asked to advise a company employing 1,500 people on how to spend a budget allocated to tackling the problem of noise-induced deafness, how would you advise the company to apportion it amongst the options listed below if the budget were (i) £5,000, (ii) £25,000, (iii) £100,000?

RESPONDENTS WHO REPLIED EITHER YES OR NO TO EACH ITEM

	£5,000	£25,000	£100,000
(a) Quietening existing plant and machinery	n.s.	n.s.	n.s.
(b) Development of methods of quietening existing plant and machinery	Somes > Yeses .01	n.s.	n.s.
(c) Designing quieter machines	n.s.	n.s.	n.s.
(d) Carrying out noise surveys	n.s.	n.s.	n.s.
(e) Providing hearing protectors	n.s.	n.s.	n.s.
(f) Noise-hazard education programmes	n.s.	n.s.	n.s.
(g) Encouraging the use of hearing protectors provided (ie. supervision, posters, training courses, etc.)	n.s.	n.s.	n.s.
(h) Audiometry	n.s.	n.s.	n.s.

continued.....

RESPONDENTS WHO USED RANKINGS ONLY

	£5,000	£25,000	£100,000
(a) Quietening existing plant and machinery	n.s.	n.s.	n.s.
(b) Development of methods of quietening existing plant and machinery	n.s.	n.s.	n.s.
(c) Designing quieter machines	n.s.	n.s.	n.s.
(d) Carrying out noise surveys	n.s.	n.s.	n.s.
(e) Providing hearing protectors	n.s.	n.s.	n.s.
(f) Noise-hazard education programmes	n.s.	n.s.	n.s.
(g) Encouraging the use of hearing protectors provided (ie.supervision,posters,training courses, etc.)	n.s.	n.s.	n.s.
(h) Audiometry	Yeses > Somes .05	n.s.	n.s.

RESPONDENTS APPORTIONING MONEY AS INTENDED BY THE INSTRUCTIONS

	£5,000	£25,000	£100,000
(a) Quietening existing plant and machinery	n.s.	n.s.	n.s.
(b) Development of methods of quietening existing plant and machinery	n.s.	n.s.	n.s.
(c) Designing quieter machines	n.s.	n.s.	n.s.
(d) Carrying out noise surveys	n.s.	n.s.	n.s.
(e) Providing hearing protectors	n.s.	n.s.	n.s.
(f) Noise-hazard education programmes	Somes > Yeses .01	n.s.	n.s.
(g) Encouraging the use of hearing protectors provided (ie supervision,posters,training courses, etc.	Somes > Yeses .025	n.s.	n.s.
(h) Audiometry	n.s.	n.s.	n.s.

ATTITUDE PART OF THE QUESTIONNAIRE

	Group Expressing Higher Mean Level of Agreement with Statement (if a Significant Difference exists between Groups)	Level of Significance
1. Industrial audiometry is a useful diagnostic tool	-	n.s.
2. Audiometry is an essential part of any hearing conservation programme	-	n.s.
3. Assessing a worker's hearing ability is not necessary in order to protect it	-	n.s.
4. A higher priority should be given to testing the hearing abilities of workers than is given at present	-	n.s.
5. Audiometry is not advisable in an industrial situation	Somes	.05
6. Audiometry has no effect on industrial relations	-	n.s.
7. Audiometry is an expensive toy for occupational physicians to play with	-	n.s.
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry	-	n.s.
9. Industrial audiometry is basically anti-worker	-	n.s.

continued.....

	Group Expressing Higher Mean Level of Agreement With Statement (if a Significant Difference exists between Groups)	Level of Significance
10. Money spent on audiometry would be better spent on noise control	Somes	.005
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing	-	n.s.
12. Audiometry and noise control are inseparable	-	n.s.
13. Firms should be compelled by law to periodically test the hearing of their employees	-	n.s.
14. Workers regard audiometry as evidence of their employer's concern for their welfare	-	n.s.
15. Audiometry can never prevent occupational deafness	-	n.s.
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme	Yeses	.001
17. The value of audiometry in industry is unestablished	Somes	.05
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss	-	n.s.

	Group Expressing Higher Mean Level of Agreement with Statement (if a Significant Difference exists between Groups)	Level of Significance
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise-induced hearing-loss	-	n.s.
20. Audiometry is an adjunct to a hearing conservation programme and no more	-	n.s.
21. Audiometry encourages the use of hearing protectors by workers	-	n.s.
22. Audiometry encourages managements to take an interest in the problem of noise at work	-	n.s.
23. Not enough is known about industrial audiometry to make statements about its usefulness	-	n.s.
24. Audiometry and hearing protection are inseparable	-	n.s.
25. Not many people in industry care very much about audiometry	-	n.s.
26. No matter what people say, testing the hearing of workers can't do anyone any harm	-	n.s.
27. Audiometry is relatively inexpensive	-	n.s.

6.1.3 Noes X Somes Analysis

6.1.3.1.
General Results: Group Similarities

There were no significant differences between the two groups as regards being full- or part-time and no signficant differences between them in terms of the priority they put on preventing the occupational injuries and disorders named in the questionnaire. Similarly there were no significant differences between the two groups in terms of research in occupational health, other medical fields worked in, the year of qualification, age structure and sex.

6.1.3.2.
General Results: Group Differences

The two groups differed significantly in the number of working sessions they did per week as part-timers, the Somes doing more. When asked why they felt other people did audiometry, the Noes ranked "to screen out individuals for further investigation" and "to detect individuals who may be an accident risk either to themselves or to others because of poor hearing ability" slightly higher up to list than did the Somes. The Somes were more likely to work in situations in which either all the organisations or none of the organisations which employed them attempted to control noise at the machinery and plant design stage while the Noes were more likely to find that some of the organisations they worked for did this. With regard to providing earmuffs and earplugs to people required to work in noisy areas, these tendencies were in the opposite direction. In programmes designed to encourage people to wear hearing protectors provided a higher proportion of Somes than Noes employed films, and talks given by medical officers.

6.1.3.3
Responses to the Attitude Part of the Questionnaire

On the attitude questionnaire there were significant differences between the two groups on 11 of the 27 statements. A higher proportion of Noes than Somes agreed that"money spent on audiometry would be better spent on noise control", that "audiometry can never prevent occupational deafness", that "the value of audiometry in industry is unestablished", and that "not enough is known about industrial audiometry to make statements about its usefulness". A higher proportion of Somes than Noes agreed that "audiometry and noise control are inseparable", that "workers regard audiometry as evidence of their employer's concern for their welfare", that " where a firm has a programme of medical screening, audiometry should be a part of that programme", that "audiometry encourages the use of hearing protectors by workers", and that "audiometry is relatively inexpensive". Both disageed that "industrial audiometry is basically anti-worker" but the Somes did so more strongly. The Noes were uncertain as to whether or not "audiometry is an adjunct to a hearing conservation programme and no more" while the Somes were polarised with a slight majority in favour of agreement.

6.1.3.4
Responses to the Hypothetical Budget Question

On the hypothetical budget question, there were no significant differences at all amongst the respondents who answered in terms of yes and no only. Amongst those respondents who ranked the options in order of priority, there was only one significant difference, namely, that the Noes ranked providing hearing protectors slightly more highly than did the Somes but only when the budget was £100,000. Amongst the respondents who answered the question as intended, the only significant differences occurred in the £5,000 budget section in which the Somes indicated that they would spend more money on noise-hazard education programmes, encouraging the use of hearing protectors provided, and audiometry, than would the Noes.

TABLE 15 Table of statistically significant differences between industrial medical officers performing audiometry in some factories but not in others (Somes) and those not performing audiometry at all (Noes). Results expressed as a function of questions asked on the questionnaire.

GENERAL SECTION

	DIRECTION OF DIFFERENCE (IF SIGNIFICANT)	LEVEL OF SIGNIFICANCE
Are you engaged in Occupational Medicine		
(a) full-time?	-	n.s.
(b) part-time?	-	n.s.
If part-time, please state the number of sessions per week	Somes > Noes	.025
and the number of hours per session	-	n.s.
For which of the reasons listed below do you think audiometry is performed by other people in industry? Please rank them in order of importance.		
(a) To screen out individuals for further investigation	Noes > Somes	.05
(b) To provide an occasion for persuading reluctant workers to wear hearing protectors which have been provided	-	n.s.
(c) To assist in the job-placement of individuals who possess a hearing-loss	-	n.s.
(d) To provide a record of changes in an individual's hearing level	-	n.s.
(e) To detect individuals who may be an accident risk either to themselves or to others because of poor hearing ability	Noes > Somes	.05
(f) To detect noise-susceptible individuals	-	n.s.
(g) To practice health surveillance	-	n.s.
(h) To provide a baseline for later comparisons	-	n.s.
(i) To provide biological monitoring	-	n.s.
(j) To provide information which may be useful in any subsequent litigation for alleged noise-induced hearing-loss	-	n.s.
(k) As an essential tool of preventive medicine	-	n.s.
(l) To reduce the strain upon NHS ear, nose and throat departments	-	n.s.
(m) Any other reason(s) (please specify)	-	n.s.

Continued.....

TABLE 15 (continued)

	DIRECTION OF DIFFERENCE (IF SIGNIFICANT)	LEVEL OF SIGNIFICANCE
In the industries or organisations in which you are employed, is it the policy to:		
(a) attempt to quieten existing noisy machinery?	-	n.s.
(b) attempt to control noise at the machinery and plant design stage?	Interaction	.01
(c) insist upon noise-limiting requirements when purchasing new plant and machinery?	-	n.s.
(d) provide for employees required to work in "noisy" areas:		
(i) ear muffs?	Interaction	.05
(ii) ear plugs?	Interaction	.025
(e) control administratively the amount of time spent by employees in "noisy" areas?	-	n.s.
Have any of the industry(ies) in which you are employed:		
(a) been involved in common law claims for alleged occupational hearing-loss whether these were settled in or out of court?	Somes > Noes	.01
(b) any common law claims for alleged occupational hearing loss outstanding at the moment?	Somes > Noes	.05
Below is a very broad classification of injuries and disorders which can have an occupational origin. Could you please rank them in order of priority as regards their prevention by placing a "1" opposite that item, the prevention of which you feel should have top priority, a "2" opposite the highest priority amongst the remaining items, and so on?		
(a) Respiratory disorders	-	n.s.
(b) Minor accidental injuries	-	n.s.
(c) Occupational cancer	-	n.s.
(d) Damage to eyesight	-	n.s.
(e) Major accidental injuries	-	n.s.
(f) Noise-induced hearing	-	n.s.
(g) Fire and explosion injuries	-	n.s.
(h) Poisoning by toxic metals (as distinct from excessive absorption)	-	n.s.
(i) Dermatitis	-	n.s.

continued.....

TABLE 15 (continued)

	DIRECTION OF DIFFERENCE (IF SIGNIFICANT)	LEVEL OF SIGNIFICANCE
If hearing protectors of any kind are provided by the industry(ies) in which you work, does the programme designed to encourage their use employ:		
(a) Posters	-	n.s.
(b) Talks given by medical officers	Somes > Noes	.05
(c) Talks given by nursing staff	-	n.s.
(d) Talks given by the safety officer or his staff	-	n.s.
(e) Talks given by managers	-	n.s.
(f) Talks given by workers' representatives	-	n.s.
(g) Advisory pamphlets	-	n.s.
(h) Films	Somes > Noes	.01
(i) Advice given by medical officers at audiometric testing sessions	Somes > Noes	.001
(j) Advice given by nursing staff at audiometric testing sessions	Somes > Noes	.001
(k) Other means (please specify)	-	n.s.
Do you conduct research in occupational health?	-	n.s.
Which other medical fields do you currently work in?		
(a) None	-	n.s.
(b) General Practice	-	n.s.
(c) University	-	n.s.
(d) Hospital	-	n.s.
(e) Other (please specify)	Somes > Noes	.05
Pleasestate the year in which you qualified	-	n.s.
Age	-	n.s.
Sex	-	n.s.

HYPOTHETICAL BUDGET QUESTION

This is a hypothetical question. If you were to be asked to advise a company employing 1,500 people on how to spend a budget allocated to tackling the problem of noise-induced deafness, how would you advise the company to apportion it amongst the options listed below if the budget were (i) £5,000, (ii) £25,000, (iii) £100,000?

RESPONDENTS WHO REPLIED EITHER YES OR NO TO EACH ITEM

	£5,000	£25,000	£100,000
(a) Quietening existing plant and machinery	n.s.	n.s.	n.s.
(b) Development of methods of quietening existing plant and machinery	n.s.	n.s.	n.s.
(c) Designing quieter machines	n.s.	n.s.	n.s.
(d) Carrying out noise surveys	n.s.	n.s.	n.s.
(e) Providing hearing protectors	n.s.	n.s.	n.s.
(f) Noise-hazard education programmes	n.s.	n.s.	n.s.
(g) Encouraging the use of hearing protectors provided (ie. supervision, posters, training courses, etc.)	n.s.	n.s.	n.s.
(h) Audiometry	n.s.	n.s.	n.s.

continued.....

RESPONDENTS WHO USED RANKINGS ONLY

	£5,000	£25,000	£100,000
(a) Quietening existing plant and machinery	n.s.	n.s.	n.s.
(b) Development of methods of quietening existing plant and machinery	n.s.	n.s.	n.s.
(c) Designing quieter machines	n.s.	n.s.	n.s.
(d) Carrying out noise surveys	n.s.	n.s.	n.s.
(e) Providing hearing protectors	n.s.	n.s.	Somes > Noes .05
(f) Noise-hazard education programmes	n.s.	n.s.	n.s.
(g) Encouraging the use of hearing protectors provided (ie.supervision,posters,training courses, etc.)	n.s.	n.s.	n.s.
(h) Audiometry	n.s.	n.s.	n.s.

RESPONDENTS APPORTIONING MONEY AS INTENDED BY THE INSTRUCTIONS

	£5,000	£25,000	£100,000
(a) Quietening existing plant and machinery	n.s.	n.s.	n.s.
(b) Development of methods of quietening existing plant and machinery	n.s.	n.s.	n.s.
(c) Designing quieter machines	n.s.	n.s.	n.s.
(d) Carrying out noise surveys	n.s.	n.s.	n.s.
(e) Providing hearing protectors	n.s.	n.s.	n.s.
(f) Noise-hazard education programmes	Somes > Noes .025	n.s.	n.s.
(g) Encouraging the use of hearing protectors provided (ie supervision,posters,training courses, etc.	Somes > Noes .025	n.s.	n.s.
(h) Audiometry	Somes > Noes .05	n.s.	n.s.

ATTITUDE PART OF THE QUESTIONNAIRE

	Group Expressing Higher Mean Level of Agreement with Statement (if a Significant Difference exists between Groups)	Level of Significance
1. Industrial audiometry is a useful diagnostic tool	-	n.s.
2. Audiometry is an essential part of any hearing conservation programme	-	n.s.
3. Assessing a worker's hearing ability is not necessary in order to protect it	-	n.s.
4. A higher priority should be given to testing the hearing abilities of workers than is given at present	-	n.s.
5. Audiometry is not advisable in an industrial situation	-	n.s.
6. Audiometry has no effect on industrial relations	-	n.s.
7. Audiometry is an expensive toy for occupational physicians to play with	-	n.s.
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry	-	n.s.
9. Industrial audiometry is basically anti-worker	Noes	.025

continued.....

	Group Expressing Higher Mean Level of Agreement With Statement (if a Significant Difference exists between Groups)	Level of Significance
10. Money spent on audiometry would be better spent on noise control	Noes	.025
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing	-	n.s.
12. Audiometry and noise control are inseparable	Somes	.01
13. Firms should be compelled by law to periodically test the hearing of their employees	-	n.s.
14. Workers regard audiometry as evidence of their employer's concern for their welfare	Somes	.05
15. Audiometry can never prevent occupational deafness	Noes	.025
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme	Somes	.025
17. The value of audiometry in industry is unestablished	Noes	.001
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss	-	n.s.

	Group Expressing Higher Mean Level of Agreement with Statement (if a Significant Difference exists between Groups)	Level of Significance
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise-induced hearing-loss	-	n.s.
20. Audiometry is an adjunct to a hearing conservation programme and no more	Somes	.01
21. Audiometry encourages the use of hearing protectors by workers	Somes	.005
22. Audiometry encourages managements to take an interest in the problem of noise at work	-	n.s.
23. Not enough is known about industrial audiometry to make statements about its usefulness	Noes	.05
24. Audiometry and hearing protection are inseparable	-	n.s.
25. Not many people in industry care very much about audiometry	-	n.s.
26. No matter what people say, testing the hearing of workers can't do anyone any harm	-	n.s.
27. Audiometry is relatively inexpensive	Somes	.025

6.1.4. Significant Factors Emerging from the Factor Analysis

The following section tabulates the significant factors to emerge from the factor analyses and subsequent factor rotations. The tables give the suggested name of each factor, the amount of variance accounted for by each factor and the scale score attaching to each. The factors are listed in order of extraction.

The tables detailing the loadings of each attitude item on each significant factor extracted are to be found in Appendix 2.

TABLE 16 Factors extracted from principal components analysis of attitude questionnaire results obtained from medical officers performing audiometry.

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR	27.3	3.595
2	INTRINSIC VALUE OF AUDIOMETRY	7.8	3.648
3	COMPENSATION-ORIENTED FACTOR	6.4	3.250
4	CYNICISM TOWARDS AUDIOMETRY	5.4	2.332
5	UNINTERPRETABLE	4.6	3.183

TABLE 17 Varimax-rotated factors extracted from analysis of attitude questionnaire results obtained from medical officers performing audiometry.

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR (NECESSITY FOR AUDIOMETRY)	55.8	3.441
2	EXISTENCE OF KNOWLEDGE OF VALUE OF AUDIOMETRY.	13.2	3.608
3	CYNICISM TOWARDS AUDIOMETRY	9.0	1.893

TABLE 18 Quartimax-rotated factors extracted from analysis of attitude questionnaire results obtained from medical officers performing audiometry.

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR (NECESSITY FOR AUDIOMETRY)	55.8	3.528
2	INTRINSIC VALUE OF AUDIOMETRY	13.2	3.627
3	USEFULNESS OF AUDIOMETRY FOR LITIGATION AND JOB PLACEMENT	9.0	3.437

TABLE 19 Equimax-rotated factors extracted from analysis of attitude questionnaire results obtained from medical officers performing audiometry.

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR	55.8	3.350
2	USEFULNESS OF AUDIOMETRY AS A GENERAL PROPAGANDA TOOL	13.2	3.945
3	CYNICISM TOWARDS AUDIOMETRY	9.0	1.896

TABLE 20 Factors extracted from principal components analysis of attitude questionnaire results obtained from medical officers not performing audiometry.

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR	29.3	2.862
2	USEFULNESS OF AUDIOMETRY AS A GENERAL PROPOGANDA TOOL	6.5	3.364
3	ADVISABILITY OF AUDIOMETRY IN INDUSTRY	6.4	3.075
4	USEFULNESS OF AUDIOMETRY FOR PRE-PLACEMENT PURPOSES (PROPHYLACTIC AUDIOMETRY)	6.3	2.998

TABLE 21 Varimax-rotated factors extracted from analysis of attitude questionnaire results obtained from medical officers not performing audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR	55.3	3.185
2	CYNICISM ABOUT USEFULNESS OF AUDIOMETRY	9.5	2.692
3	NECESSITY OF AUDIOMETRY	9.3	2.856
4	USEFULNESS OF AUDIOMETRY AS A PROPAGANDA TOOL	8.3	3.396

TABLE 22 Quartimax-rotated factors extracted from analysis of attitude questionnaire results obtained from medical officers not performing audiometry.

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR	55.3	3.089
2	AUDIOMETRY AS A STIMULATOR OF MANAGEMENT INTEREST IN NOISE	9.5	3.629
3	PERCEIVED CONCERN FOR WORKERS' HEARING BY MANAGEMENT	9.3	3.212
4	FEAR-OF-LITIGATION FACTOR	8.3	3.604

TABLE 23 Equimax-rotated factors extracted from analysis of attitude questionnaire results obtained from medical officers not performing audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR	55.3	3.085
2	AUDIOMETRY AS AN EDUCATIONAL DEVICE FOR ALL SIDES OF INDUSTRY	9.5	3.477
3	AGGRESSIVE OPPOSITION TO AUDIOMETRY	9.3	2.560
4	NECESSITY FOR AUDIOMETRY	8.3	2.624

TABLE 24 Factors extracted from principal components analysis of attitude questionnaire results obtained from medical officers performing audiometry in some companies, but not in others

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR	37.6	3.462
2	RETICENCE OVER AUDIOMETRY'S LITIGATION VALUE TO THE EMPLOYER	8.4	3.638
3	DIAGNOSTIC VALUE OF AUDIOMETRY INDEPENDENT OF OTHER CONSIDERATIONS	8.2	3.459

TABLE 25 Varimax-rotated factors extracted from analysis of attitude questionnaire results obtained from medical officers performing audiometry in some companies but not in others.

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR	54.4	3.543
2	USEFULNESS OF AUDIOMETRY Vs. OPPOSITION TO IT	10.8	3.756
3	NECESSITY OF AUDIOMETRY	10.3	3.134
4	USEFULNESS OF AUDIOMETRY FOR JOB-PLACEMENT PURPOSES	7.8	3.574

TABLE 26 Quartimax-rotated factors extracted from analysis of attitude questionnaire results obtained from medical officers performing audiometry in some companies but not in others.

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	EVALUATIVE FACTOR	54.4	3.460
2	LITIGATION VALUE OF AUDIOMETRY TO WORKERS	10.8	3.854
3	USEFULNESS OF AUDIOMETRY	10.3	4.324
4	USEFULNESS OF AUDIOMETRY FOR PRE-PLACEMENT AND EDUCATIVE PURPOSES	7.8	3.175
5	NECESSITY OF AUDIOMETRY	5.9	3.096

TABLE 27 Equimax-rotated factors extracted from analysis of attitude questionnaire results obtained from medical officers performing audiometry in some companies but not in others.

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	CYNICISM TOWARDS AUDIOMETRY	54.4	2.557
2	NECESSITY OF AUDIOMETRY	10.8	3.204
3	EVALUATIVE FACTOR	10.3	3.659
4	AUDIOMETRY AS A PROPAGANDA DEVICE DIRECTED AT WORKERS	7.8	3.268
5	USEFULNESS Vs ANTI-WORKER BIAS OF AUDIOMETRY	5.9	3.752
6	USEFULNESS OF AUDIOMETRY AS A DEVICE FOR ENCOURAGING WORKERS' COMPLIANCE IN WEARING HEARING PROTECTION	5.7	3.624

6.2 Workers Questionnaires

6.2.1 Preamble

Child (1970) recommended that in order to perform a factor analysis with any degree of confidence, a sample of at least 50 respondents is necessary owing to the unstable nature of correlation coefficients in small samples. This requirement was met in the cases of Firms 1 and 2, but not, unfortunately in the case of Firm 3. Firm 3's analysis must therefore be treated very cautiously. The same author also recommended that at least three significant loadings must exist on a factor before that factor can be established. Therefore only factors with three or more items loading significantly upon them were considered for interpretation.

The results of the audiometry questionnaire will be summarised first, in the form of tables giving the number of significant factors extracted for each firm by each factor analytical variation and the loading of each questionnaire item on these factors for each firm. Similarly the results of the analyses of the hearing protectors questionnaire will be summarised next. Following that will be tables giving suggested interpretations for the factors extracted, first of all for the audiometry questionnaire in all three firms and for all analytical variations used and then again for the hearing protectors questionnaire.

6.2.2. Tabulation of Significant Factors Extracted

6.2.2.1 Audiometry Questionnaire

A summary of the factors extracted and the mean scores obtained is as follows:

TABLE 28 Firm 1: Principal Components Analysis. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	GENERAL EVALUATION OF AUDIOMETRY	17.9	4.212
2	AUDIOMETRY INCREASES CONCERN FOR HEARING	13.4	3.387
3	AUDIOMETRY INCREASES AWARENESS OF HEARING	9.0	3.770
4	N.H.S. RESPONSIBILITY FOR TESTING HEARING V EMPLOYER'S RESPONSIBILITY	7.3	2.585
5	USEFULNESS OF AUDIOMETRY	5.8	3.615

TABLE 29 Firm 1: Varimax Rotation. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	AUDIOMETRY AS A SIGN OF MANAGEMENT CONCERN FOR THE HEARING OF ITS EMPLOYEES	25.9	4.137
2	AUDIOMETRY INCREASES AWARENESS OF HEARING	19.2	3.950
3	RESPONSIBILITY FOR TESTING HEARING N.H.S. v EMPLOYER (OR INAPPROPRIATENESS OF DOING AUDIOMETRY AT WORK)	12.2	1.780
4	POINTLESSNESS OF AUDIOMETRY	9.6	1.443
5	SUSPICION OF EMPLOYERS' MOTIVES FOR DOING AUDIOMETRY	7.3	3.106

TABLE 30 Firm 1: Quartimax Rotation. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	AUDIOMETRY IS A SIGN OF EMPLOYERS' CONCERN FOR THE HEARING OF THEIR EMPLOYEES	25.9	4.194
2	AUDIOMETRY INCREASES AWARENESS OF HEARING	19.2	3.948
3	RESPONSIBILITY FOR TESTING HEARING, N.H.S. V EMPLOYER (INAPPROPRIATENESS OF DOING AUDIOMETRY AT WORK)	12.2	1.782
4	POINTLESSNESS OF AUDIOMETRY	9.6	1.443
5	SUSPICION OF EMPLOYERS' MOTIVES FOR DOING AUDIOMETRY	7.3	3.110

TABLE 31 Firm 1: Equimax Rotation. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	POINTLESSNESS OF AUDIOMETRY	25.9	1.445
2	AUDIOMETRY INCREASES AWARENESS OF HEARING	19.2	3.952
3	RESPONSIBILITY FOR TESTING HEARING, N.H.S. V EMPLOYER (OR INAPPROPRIATENESS OF DOING AUDIOMETRY AT WORK)	12.2	1.779
4	USEFULNESS OF AUDIOMETRY	9.6	4.337
5	SUSPICION OF EMPLOYERS' MOTIVES FOR DOING AUDIOMETRY	7.3	3.104

TABLE 32 Firm 2: Principal Components Analysis. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	GENERAL EVALUATION OF AUDIOMETRY	18.6	4.142
2	USEFULNESS OF AUDIOMETRY	13.2	4.208
3	AUDIOMETRY AS AN INCREASER OF AWARENESS OF HEARING	10.0	3.759
4	NECESSITY FOR AUDIOMETRY	8.6	3.477
5	AUDIOMETRY: EXERCISE OF WORKERS' RIGHT V COMPULSION	7.6	3.339

TABLE 33 Firm 2: Varimax Rotation. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	USEFULNESS OF AUDIOMETRY	28.2	3.435
2	AUDIOMETRY AS AN INCREASER OF AWARENESS OF HEARING V AUDIOMETRY AS A COMPENSABLE TIME-WASTER	19.6	1.665
3	USEFULNESS OF AUDIOMETRY OUTSIDE A MEDICAL CONTEXT	14.1	3.847
4	APPROPRIATENESS OF DOING AUDIOMETRY AT WORK	11.6	3.681
5	AUDIOMETRY INCREASES FEAR OF HEARING LOSS	9.7	4.056

TABLE 34 Firm 2: Quartimax Rotation. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	USEFULNESS IN TERMS OF EFFECT UPON JOB AND EARNINGS	28.2	4.351
2	USEFULNESS TO EMPLOYEES AND MANAGEMENT	19.2	3.415
3	ACCEPTABILITY OF AUDIOMETRY	14.1	3.838
4	RESPONSIBILITY FOR TESTING HEARING, N.H.S. V EMPLOYER (i. e. SUSPICION OF EMPLOYERS' MOTIVES)	11.6	2.296
5	AUDIOMETRY INCREASES FEAR OF HEARING LOSS	9.7	4.058

TABLE 35 Firm 2: Equimax Rotation. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	AUDIOMETRY AS AN INCREASER OF FEAR OF HEARING LOSS	28.2	4.061
2	APPROPRIATENESS OF DOING AUDIOMETRY AT WORK	19.6	3.843
3	USEFULNESS OF HEARING TESTS (DONE, PREFERABLY, BUT NOT NECESSARILY, BY THE N.H.S.)	14.1	3.321

continued.....

TABLE 35 Continued

4	RESPONSIBILITY FOR TESTING HEARING: N.H.S. v EMPLOYER (SUSPICION OF EMPLOYERS' MOTIVES FOR DOING AUDIOMETRY)	11.6	2.624
5	USEFULNESS OF AUDIOMETRY: JOB V PERSONAL CONSIDERATIONS	9.7	4.323
6	ENCOURAGEMENT V WORRY VALUE OF AUDIOMETRY	7.0	1.964

TABLE 36 Firm 3: Principal Components Analysis. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	GENERAL EVALUATIVE OR NEBULOUS CONCERN FOR HEARING FACTOR	30.3	3.861
2	USEFULNESS (NECESSITY?) OF AUDIOMETRY AT WORK	19.3	3.943

TABLE 37 Firm 3: Varimax Rotation. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	APPROPRIATENESS OF AUDIOMETRY AT WORK	33.9	3.935
2	AUDIOMETRY AS AN INCREASER OF AWARENESS OF HEARING	21.5	4.045
3	N.H.S. RESPONSIBILITY FOR TESTING HEARING	12.8	2.280

TABLE 38 Firm 3: Quartimax Rotation. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	NECESSITY OF AUDIOMETRY (A SIGN OF EMPLOYERS' CONCERN BOTH FOR THE HEARING OF HIS EMPLOYEES AND FOR FINANCIAL CONSIDERATIONS)	33.9	4.126
2	AUDIOMETRY SEEN AS A VOLUNTARY EXERCISE OF LIMITED USEFULNESS V AUDIOMETRY AS A COMPULSORY EXERCISE OF WIDE USEFULNESS	21.5	2.011

TABLE 39 Firm 3: Equimax Rotation. Audiometry

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	REASONABLENESS OF AUDIOMETRY V LIMITED USEFULNESS OF AUDIOMETRY	33.9	3.906
2	AUDIOMETRY AS A SIGN OF EMPLOYERS' CONCERN FOR THE HEARING OF HIS EMPLOYEES	21.5	4.345
3	WORKERS' FINANCIAL BENEFIT V EVERYONE'S BENEFIT (PARTICULARLY MANAGEMENT'S)	12.8	2.919
4	RESPONSIBILITY FOR TESTING HEARING, N.H.S. V EMPLOYER	10.5	2.293
5	AUDIOMETRY AS AN INCREASER OF AWARENESS OF HEARING	7.0	4.187

6.2.2.2. Tabulation of Significant Factors Extracted: Hearing Protectors Questionnaire

TABLE 40 Firm 1: Principal Components Analysis. Hearing Protectors

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	GENERAL EVALUATIVE FACTOR	23.189	4.081
2	PERCEIVED FREEDOM OF CHOICE TO WEAR HEARING PROTECTORS (LINKED TO SUSPICION OF EMPLOYERS' MOTIVES AND EFFECT OF HEARING PROTECTORS ON APPEARANCE)	12.188	1.845
3	RESPONSIBILITY FOR PROTECTING HEARING, EMPLOYER V EMPLOYEES	10.035	3.180
4	NECESSITY FOR PROVISION OF HEARING PROTECTORS V FREEDOM OF CHOICE TO WEAR THEM	7.09	3.043
5	DISTASTFULNESS OF HEARING PROTECTORS	5.053	2.513

TABLE 41 Firm 1: Varimax Rotation. Hearing Protectors

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	USEFULNESS (NECESSITY?) OF HEARING PROTECTORS	11.218	2.565
2	HEARING PROTECTORS SPOIL PERSONAL APPEARANCE	10.414	1.662
3	SHOULD WEARING OF HEARING PROTECTORS BE VOLUNTARY OR COMPULSORY	9.768	3.988
4	ACCEPTABILITY OF HEARING PROTECTORS (EMOTIONAL FACTOR)	7.775	3.150
5	USEFULNESS OF HEARING PROTECTORS TO THE HARD OF HEARING	7.491	2.524
6	ACCEPTABILITY OF HEARING PROTECTORS (COMFORT, ETC.)	7.268	3.328
7	EMPLOYERS' RESPONSIBILITY FOR PROTECTING HEARING (ESPECIALLY WOMEN'S)	6.913	2.134

TABLE 42 Firm 1: Promax Rotation. Hearing Protectors

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	USEFULNESS OF HEARING PROTECTORS. GENERAL EVALUATIVE FACTOR	The computer package used does not provide this information for Promax Rotation	1.376
2	HEARING PROTECTORS SPOIL PERSONAL APPEARANCE		1.667
3	SHOULD WEARING OF HEARING PROTECTORS BE VOLUNTARY OR COMPULSORY		3.716
4	ACCEPTABILITY OF HEARING PROTECTORS (EMOTIONAL FACTOR ASSOCIATING HEARING PROTECTORS WITH FULFILMENT OF MANAGERIAL RESPONSIBILITY)		3.273
5	AVOIDABILITY V INEVITABILITY OF HEARING LOSS		3.597
6	MANAGEMENT RESPONSIBILITY FOR PREVENTING HEARING LOSS (HEARING PROTECTORS AS A WAY OF EMPLOYERS DUCKING RESPONSIBILITY)		1.978
7	USEFULNESS OF HEARING PROTECTORS TO THE HARD OF HEARING		4.244
8	(ONLY 2 ITEMS LOAD SIGNIFICANTLY ON THIS FACTOR)		2.142
9	NECESSITY OF HEARING PROTECTORS		1.574
10	NOISE CONTROL V HEARING PROTECTION		3.740
11	EMPLOYEE V EMPLOYER RESPONSIBILITY FOR PREVENTING HEARING LOSS		2.148

TABLE 43   Firm 2: Principal Components Analysis.   Hearing Protectors

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	GENERAL EVALUATIVE FACTOR	16.061	3.435
2	ENTHUSIASM V NON-INVOLVEMENT (EMOTIONAL FACTOR)	12.775	2.070
3	APATHY V INTEREST (NON-EMOTIONAL FACTOR)	10.623	2.780
4	HEARING LOSS: EMPLOYERS' FAULT V NOBODY'S FAULT	8.517	2.963
5	NECESSITY FOR HEARING PROTECTORS	7.396	3.152
6	PERCEIVED FREEDOM OF CHOICE	5.741	2.458
7	USEFULNESS OF HEARING PROTECTORS	4.706	3.523

TABLE 44   Firm 2: Varimax Rotation.   Hearing Protectors

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	NECESSITY FOR HEARING PROTECTORS	11.149	3.707
2	FREEDOM OF CHOICE TO WEAR HEARING PROTECTORS (SEEN AS MANAGEMENT LARGESSE)	9.688	3.693
3	INDIFFERENCE V INVOLVEMENT IN THE HEARING PROTECTION ISSUE	9.638	1.892
4	GRUDGING ACCEPTANCE OF NECESSITY FOR HEARING PROTECTORS	9.058	3.536
5	ACCEPTABILITY OF HEARING PROTECTORS USEFULNESS OF HEARING PROTECTORS	8.323	2.714
6	MANAGEMENT V EMPLOYEE RESPONSIBILITY EMPLOYEE HELPLESSNESS V EMPLOYEE CONTROL	8.127	3.163
7	MASCULINITY V FEMININITY OF HEARING PROTECTORS	5.489	3.556
8	EMPLOYERS' RESPONSIBILITY FOR PROTECTING HEARING	5.488	3.939

TABLE 45 Firm 2: Promax Rotation. Hearing Protectors

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	NECESSITY FOR HEARING PROTECTORS (i.e. ARE THEY A MANAGEMENT PLOY & THEREFORE NOT NECESSARY)	The computer package used does not provide this information for Promax Rotation	3.618
2	THERE SHOULD BE FREEDOM OF CHOICE TO WEAR HEARING PROTECTORS PROVIDED OUT OF MANAGEMENT CONCERN FOR EMPLOYEES' HEARING V HEARING PROTECTORS AS AN UNNECESSARY IRRELEVANCE		3.767
3	BLAND ACCEPTANCE OF HEARING PROTECTORS V CRITICAL APPRAISAL		1.953
4	NECESSITY FOR WEARING HEARING PROTECTORS (WHICH ARE UNPLEASANT) WHICH MANAGEMENT HAS A DUTY TO PROVIDE		3.605
5	WORKER HELPLESSNESS V WORKER CONTROL OVER HEARING LOSS		3.023
6	POINTLESSNESS OF HEARING PROTECTORS		2.809
7	MASCULINITY V FEMININITY OF WEARING HEARING PROTECTORS		3.567
8	MANAGEMENT RESPONSIBILITY FOR PREVENTING HEARING LOSS		2.543

TABLE 46 Firm 3: Principal Components Analysis. Hearing Protectors

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	USELESSNESS OF HEARING PROTECTORS	22.634	1.759
2	EMPLOYERS' RESPONSIBILITY FOR PROTECTING HEARING, ESPECIALLY THAT OF WOMEN	17.770	3.857

TABLE 47 Firm 3: Varimax Rotation. Hearing Protectors

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	USELESSNESS OF HEARING PROTECTORS	19.968	1.756
2	ACCEPTABILITY OF HEARING PROTECTORS (COMFORT, HYGIENE, ETC.).	12.486	2.703
3	THERE SHOULD BE FREEDOM OF CHOICE BECAUSE HEARING PROTECTORS ARE USEFUL V NO FREEDOM OF CHOICE BECAUSE HEARING PROTECTORS ARE NOT NECESSARILY USEFUL	11.249	2.532

TABLE 47 (continued)

4	EMPLOYERS' RESPONSIBILITY FOR PROTECTING WORKERS' HEARING	10.050	1.869
5	HEARING PROTECTORS SPOIL PERSONAL APPEARANCE	9.352	2.337

TABLE 48 Firm 3: Promax Rotation. Hearing Protectors

FACTOR NO.	SUGGESTED FACTOR NAME	% VARIANCE	FACTOR SCALE SCORE
1	USELESSNESS OF HEARING PROTECTORS	The computer package does not provide this information for Promax Rotation	1.758
2	SHOULD WEARING HEARING PROTECTORS BE VOLUNTARY OR COMPULSORY		3.707
3	ACCEPTABILITY OF HEARING PROTECTORS (COMFORT, HYGIENE, ETC.)		3.201
4	HEARING PROTECTORS SPOIL PERSONAL APPEARANCE		2.334
5	EMPLOYERS' RESPONSIBILITY FOR PROTECTING WORKERS' HEARING		4.153

6.3 Personal Hearing Protector Surveys

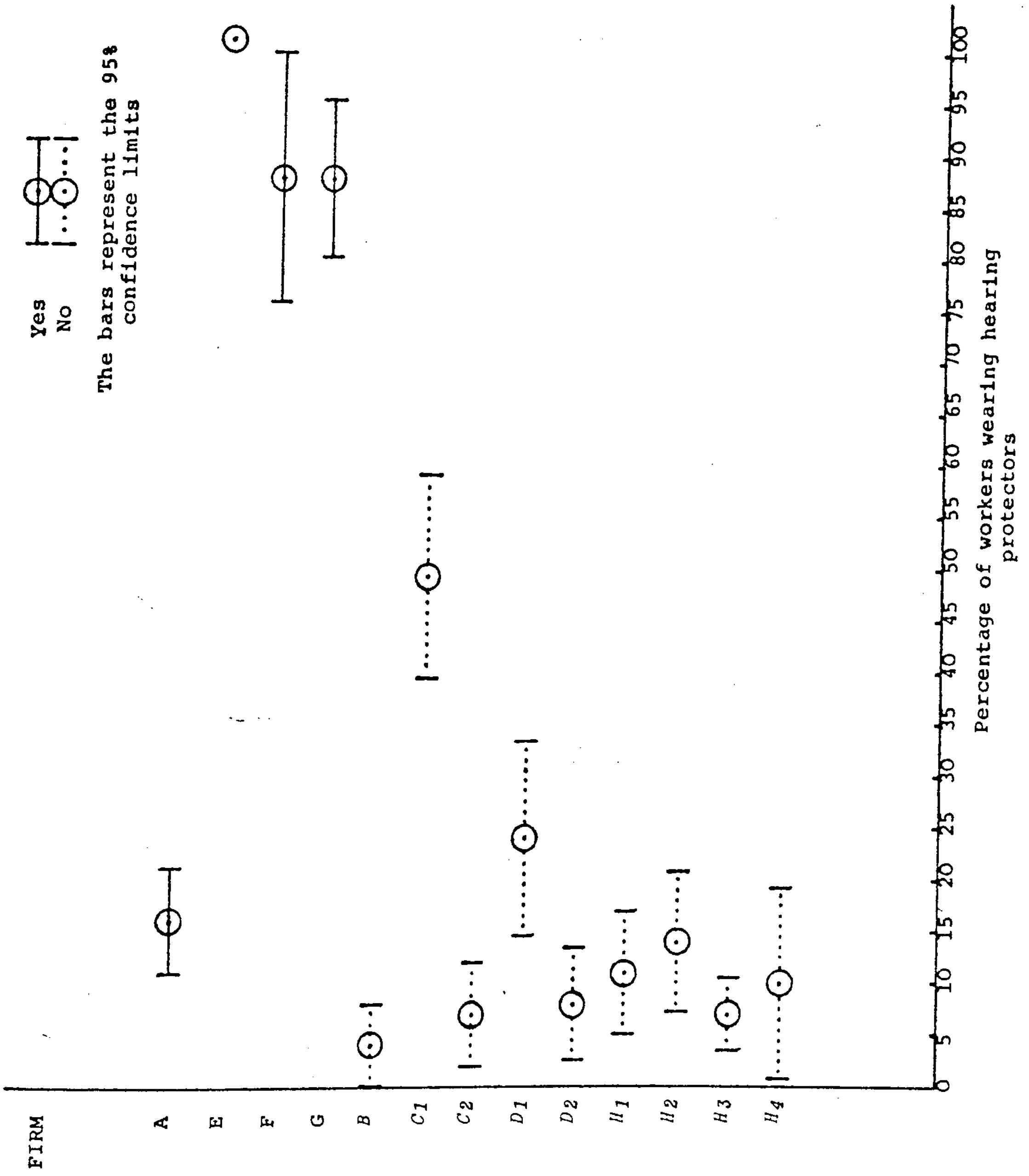
TABLE 49 Results of Hearing Protector Surveys

FIRM	SIZE OF WORKFORCE IN AREA SAMPLED	IS AUDIOMETRY PERFORMED?	PERCENTAGE OF WORKFORCE WEARING HEARING PROTECTORS
A	206	Yes	16 (±4.94)
B	100	No	4 (±3.84)
C		No	
Drop-forging shop	102		49 (±9.70)
Stamping shop	99		7 (±5.02)
D		No	
First fettling shop	80		24 (±9.37)
Second fettling shop	96		8 (±5.43)
E	56	Yes	100 (±0.00)
F	31	Yes	87 (±11.84)
G	79	Yes	87 (±7.41)
H		No	
First fettling shop	100		11 (±6.13)
Second fettling shop	100		14 (±6.80)
Third fettling shop	200		7 (±3.55)
Fourth fettling shop	40		10 (±9.29)

(The figures in brackets represent the 95% confidence limit)

FIGURE 3

The percentage of workers wearing hearing protectors in firms performing audiometry (coded 'Yes') and firms not performing audiometry (coded 'No').



6.4 Results of the Detailed Interviews

The two companies performing audiometry have been named A1 and A2 while the three companies not performing audiometry have been named N1, N2 and N3.

The results have been expressed in tabular form.

TABLE 50

GENERAL INFORMATION SOUGHT	COMPANIES				
	A1	A2	N1	N2	N3
1. Noise levels in dB(A)	83-96.5	79-115	77-115	81-100	78-107
2. Number of workers employed on the premises	15,000	12,000	2,000	9,500	10,500
3. Number of workers employed in areas of 90 dB(A) or more	1,000 approx.	110	480	40	Not available
4. Types of hearing protectors provided	Muffs, plugs, according to choice	Muffs, plugs, according to choice	Muffs, plugs, according to choice	Muffs, plugs, according to choice	One sort of muffs only. 2 or 3 sorts planned for the future
5. Instructions given to people on the use of hearing protectors	Given briefly at time of issue	Given by nurse	Detailed instructions on correct use and maintenance given at time of issue	None	Given briefly at time of issue

continued.....

	A1	A2	N1	N2	N3
6. Method by which workers can obtain hearing protectors	From Foremen's offices	From Stores or Supervisor	From Safety Officer after referral by Department head	From Manager on request	On demand from Supervisor
7. Estimates of temperature in the factory	Not available	Not available	60-90°F according to process	Not available	Not available
8. Estimates of humidity in the factory	Not available	Not available	Not available	Not available	Not available
9. Types of dust present in the factory	Silica, Calcium Carbonate, Fluorides, Iron Oxide	Flour Dust	Silica, Calcium Carbonate, Fluoride, Iron Oxide	Carbon	Not available
10. Types of work done by company	Steel production, Steel rolling	Making confectionary	Metal castings	Making tyres	Printing, Woodworking, Chemical Processes
11. Other protective equipment workers are required to wear	Eye protection, safety helmets	Whatever the job requires	Gloves, Eye Protection, Protective Boots, Spats, Gaiters, Safety Helmets (as required)	Gloves, Eye Protection, Respiratory masks (where necessary)	Whatever the job requires

continued.....

	A1	A2	N1	N2	N3
12. Regulations currently in force (besides the Health & Safety at Work etc. Act 1974)	Protection of Eyes regulations 1974	Various related to Food Industries	Many. Internal factory regulations in preparation	Many. Noise-limiting requirements on new machinery under discussion	None. Noise-limiting requirements on new machinery
13. A. Occupational Physician B. Safety Officer C. Industrial Hygienist	Full-time Full-time Full-time	Full-time Full-time Full-time	Full-time Full-time No I.H.	Part-time Full-time No. I.H.	Full-time Full-time No I.H.
14. The size of the medical department in terms of staff	38 (including 3 medical officers)	12 (including 1 medical officer)	6 (2 sisters, 3 First aiders 1 medical officer	8 (plus 1 medical officer)	50 approx.
15. Finance allotted to the medical department (at the time of enquiry)	£130,000 per annum	£45,000 per annum	No budgetary control	Not available	Not available
16. The nature of any campaign in progress aimed at persuading workers of the need to wear hearing protectors.	Posters, advice at audiometric testing sessions talks and noise survey reports given to Trade Union reps.at Section Safety Committee	Posters, Films talks to workers, advice at audiometric testing sessions	Posters, Films lectures to shop-floor by safety officer and medical staff, personal approaches by safety officer	Posters,advice from managers	Posters, films, lectures by medical officer managers and Trade Union reps. making the D.E. Code of Practice available,giving instructions on how to obtain protectors.New entrants given priority.

	A1	A2	N1	N2	N3
17. Do supervisory staff wear hearing protectors in areas of 90 dB(A) or more?	Yes	Yes	Some do. (Safety officer said that supervision is is not very good	Yes	Yes (in theory) Not often (in practice)
18. Do visitors wear hearing protectors in areas of 90 dB(A) or more?	Yes	Yes	No (unless exposure warrants it)	Yes	Yes (in theory) Not often (in practice)
19. Is the wearing of hearing protectors a condition of employment?	No	No	No	No	Yes (Information on enforcement not available)
20. Are there, or have there been, common law claims against the company by workers for alleged noise-induced hearing loss?	No	Yes, 2 current, none previously	Yes, 1 current, none previously	No	No

6.4.1 Extra Information Provided by Company N3

Company N3 also provided the following information by way of expansion of the tabulated material.

Noise control is apparently given a higher priority than the provision of hearing protectors. All the companies interviewed said this, but company N3 was more explicit, in terms of detail, and less ready with reasons for why noise control was not reasonably practicable. However, in Company N3, departmental managers accept noise control on four conditions:-

1. That it does not interfere with production
2. That it does not interfere with access for working
3. That it does not interfere with access for maintenance
4. That it is not too costly although noise control solutions are not rejected arbitrarily on grounds of cost.

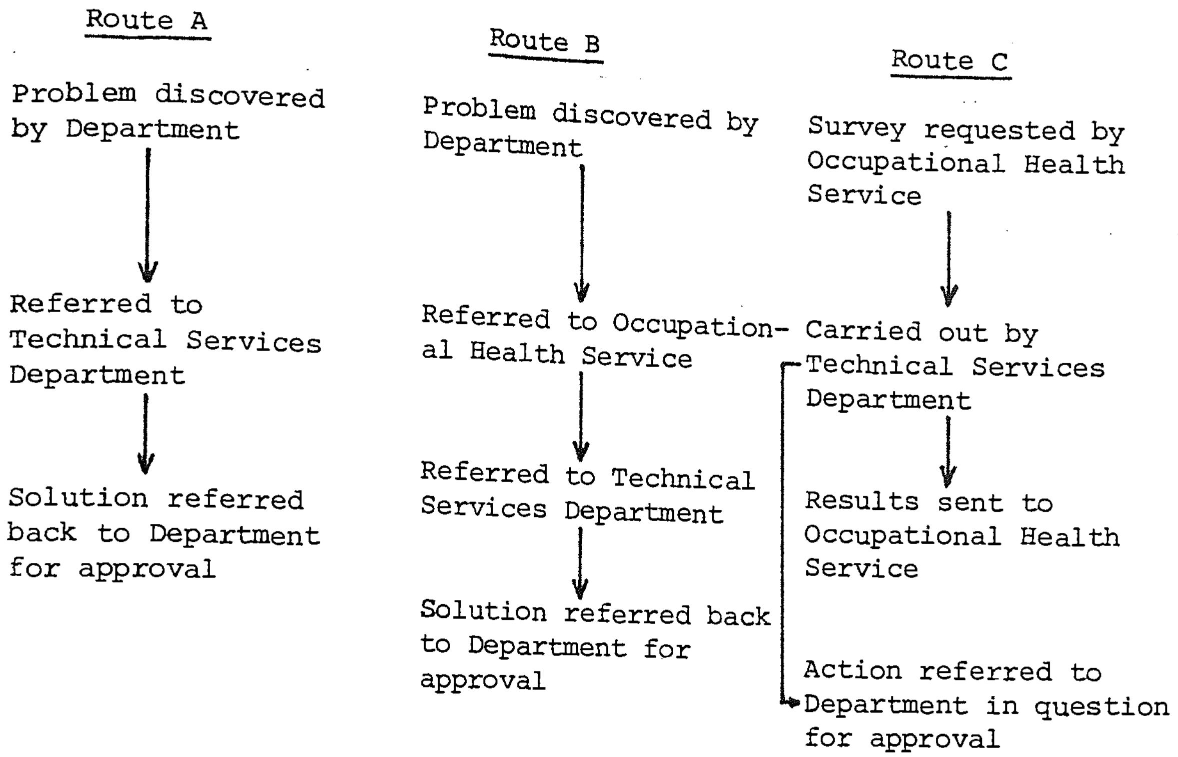
There are, apparently, five reasons for taking action against noise:-

1. To assist production
2. To reduce costs
3. To prevent harm to workers, both physically and socially
4. To prevent neighbourhood noise
5. To pre-empt future legislation

Money for noise control solutions is derived from departmental budgets though much of the money for research is provided by the Technical Services Department. No budgetary control is exercised over solutions which cost in the region of £300 or less. The interviewees said that departmental managers prefer noise control to hearing protection because they realise the discomfort and social isolation created by hearing protectors.

Copies of Safety Committee minutes are posted around the factories for all to read if they wish. The Safety Committee sets up sub-committees to look at specific problems, of which noise is one. One interviewee said that sometimes people complaining about noise to departmental managers are referred to the medical department so that the manager may be spared the problem. This practice is disliked by the medical department.

There is extensive liaison between the Medical Department, the Technical Services Department and management on noise. The Technical Services Department, which also carries out the functions of an industrial hygienist, is called in on request, except for some routine environmental surveys. Action on noise follows one of three possible routes:-



There is continual liaison between all concerned.

Interest in noise first began in 1965 in the medical department which gradually began to involve the Technical Services Department in tackling more complex noise problems. Management appeared to respond with passive, tolerant co-operation and resistance was experienced. Eventually management was persuaded that legislation on noise at work was inevitable eventually and that preparations made in advance would be more advantageous than suddenly enforced compliance with the law whenever it came.

Extensive contact occurs between management, safety and health services, and workers both on a formal and, more importantly, an informal level. All sides are kept informed. Industrial unrest is relatively rare, apparently.

6.4.2. More Specific Information Concerning Companies A1 and A2

TABLE 51 More Specific Information about the Audiometry Programmes Carried out by Companies A1 and A2

INFORMATION SOUGHT	COMPANY	
	A1	A2
1. Is the audiometry manual or automatic?	Automatic	Manual
2. Is the audiometry serial and, if so at what time intervals?	Yes. 4 years	Yes. Mostly 1-2 years
3. If referrals to N.H.S. E.N.T. services are made, what criteria are used?	a. If pathology exists b. If hearing loss equals at least 50 dB averaged over 1,2 and 3 kHz	"Those individuals who might benefit from further tests"
4. If the audiometry is used for baseline purposes, how many audiograms are taken?	2	1
5. Is audiometry performed pre-employment?	No	No
6. Is audiometry performed pre-placement?	No	Yes
7. Is audiometry performed post-employment or post-placement?	No	Yes
8. What frequencies are tested?	½, 1, 2, 3, 4, 6, 8 kHz	¼, ½, 1, 2, 4, 8, kHz
9. What arrangements are made for dealing with T.T.S.	None	Testee is told to wear hearing protectors on the day of the test before coming for the test

Continued.....

TABLE 51 Continued

INFORMATION SOUGHT	COMPANY	
	A1	A2
10. Are testees informed of results? If so, by whom?	Yes. By both the audiometrician and the medical officer	Yes. By either the audiometrician or the medical officer.
11. By whom are testees advised to wear hearing protectors	Both the medical officer and the audiometrician	Both the audiometrician and the medical officer if the latter is required to see the individual
12. When was the audiometry programme first started?	January 13th 1964	April 17th 1972
13. Who initiated it and why was it introduced?	The Medical Department in order to gain information on the incidence of hearing loss in the company	Various safety and health committees as one of the later measures envisaged for tackling the problem of noise-deafness
14. No. of people tested in total and per unit time	8,593 first audiograms and 2,179 repeat audiograms at time of enquiry. 6 to 8 people are tested per day	2,190
15. What criteria are used for selecting people for testing?	All those working in 90 dB(A) or more	Not available
16. Is the audiometry performed by the firm or by outside bodies employed for the purpose?	By the firm	By the firm
17. What are the results of the audiometry programme used for?	"Scientific analysis but with limited success".	Not available

CHAPTER 7

DISCUSSION OF THE RESULTS

7.1 The Medical Officers' Questionnaire

7.1.2 General Discussion

It can be seen immediately that there are no major personal differences between the three groups in the sample although the Noes were a slightly older group than the others. The Somes were very similar to the Yeses in all respects other than work organisation where they were similar to the Noes. Thus, the Yeses were more likely to be full-time rather than part-time while for the Noes and the Somes being part-time was the norm. This could reflect the size of the company employing them. Yeses and Somes were associated with more varied anti-occupational-deafness programmes than were Noes. Similarly Yeses and Somes were associated with more varied programmes designed to encourage the wearing of hearing protectors that had been provided. Yeses and Somes were more likely than Noes to be employed by companies which were or had been involved in litigation over alleged occupational deafness. All the groups put the same prevention priorities on the list of occupationally-induced injuries and disorders that was provided and they all felt the same about why people other than themselves performed audiometry. (The slight differences that actually occurred have been ignored as it is not probable that they alter the picture substantially).

From the attitude questionnaire it would appear that the Yeses are stronger supporters of industrial audiometry than are the Noes. This is not too surprising, but the impression given by the questionnaire is that the Yeses show a large measure of enthusiasm while the Noes have a more cautious, sceptical approach. The Somes are similar to the Yeses only they seem to display a certain amount of caution not obvious amongst the Yeses.

One or two interesting points emerge from the hypothetical budget question. One is that not all Yeses are in favour of industrial audiometry and not all Noes are against it. Similarly for the Somes. Another is that the differences between the Yeses and the Noes is not very great as evidenced by the dearth of significant differences both between the Yeses and the Somes and the Noes and the Somes. But the differences that do exist support the notion that the Noes display more caution in their judgements than do the Yeses. The evidence for this is that the differences between the two groups increase as the imaginary budget allotted increases with the difference being always in the direction of greater spending on the part of the Yeses. Why these differences only show up in the one response type is not apparent.

7.1.2.1. Conclusions of the General Discussion

Thus, it would seem that, while medical officers in general are a fairly homogeneous group, the Yeses are more enthusiastic and varied in their approach to occupational deafness while the Noes are more cautious and sceptical. The Somes seem to display enthusiasm tempered with a little more caution. Also it would seem that audiometry is associated with a more varied and rigorous campaign against occupational deafness. Audiometry is also associated with common law claims against the company for alleged industrial deafness and so it may be that audiometry - a medical test - is being done for non-medical reasons.

7.1.3 The Factor Analytic Data

If the factor analytic data derived from the attitude questionnaire are considered then it is clear that only one factor emerges which is robust enough to survive all of the analytical variations used. This is true of all three groups of respondents. That factor has been called an evaluative one and it occurs as the first factor to be extracted in every analysis but one. (This exception is the equimax rotation of the factor analytic data obtained from the sample of medical officers performing audiometry in some companies but not in others. Why this anomaly should have occurred is strange, but it is probably not significant.) This evaluative factor ususally accounts for by far the largest share of the variance and in most cases appears as a general factor - that is most of the items on the attitude questionnaire load significantly on it. It is this that makes identification of the factor so difficult. It may be a general evaluative factor as it has been named though this is very vague and tells us little other than that in one sense most of the items on the questionnaire are tapping the same dimension, though what this dimension represents is difficult to say. It may represent something unrelated to audiometry at all such as response bias - a tendency towards the same response to every item on a questionnaire (for example, a tendency to agree with every statement). Also the amount of variance accounted for by a factor is not a function of that factor's psychological significance but a function of the items on the test. In addition, the amount of variance accounted for by a factor and the number of items that load significantly upon it tend to be related (as discussed earlier) and so a phenomenon such as response bias could produce a general factor. Yet again the explanation for this general factor may lie elsewhere. The main point though is that this factor that has been labelled as evaluative may not be so in fact. This must be borne in mind throughout the remainder of this discussion section. (It must also be borne in mind whenever a factor labelled as evaluative occurs in the discussions of the Worker's Questionnaire). However, as there was a difference between the scores obtained on this factor from the three groups of respondents, it is more reasonable to assume that the factor is indeed related to audiometry in some way. Thus, the naming of the factor as evaluative is retained for discursive purposes, subject to the considerations just discussed.

All the other factors extracted appear vague and ill-defined. None of them is robust enough to survive all the analytical variants and so theri reality must be accepted reservedly. They do, however, appear to group together into several types of factor. In addition to the evaluative factor referred to above, the group of respondents performing audiometry tend to conceptualise industrial audiometry in terms of cynicism towards it, its intrinsic usefulness, and its litigation-value, to a lesser extent. Similarly the group of respondents not performing audiometry tend to conceptualise it in terms of its value as an educational or propaganda device, its necessity, and to a lesser extent cynicism or aggression towards it. Likewise the third group of respondents tend to regard industrial audiometry in terms of its necessity, its usefulness (in a vague sort of way), and in ill-defined forms of conceptualisation mentioned in the context of the other two groups.

Respondents who perform audiometry tend to evaluate it favourably, though not strongly so, are quite strongly non-cynical towards (not sceptical of) it, regard it as intrinsically useful, and tend to feel it is useful in the field of litigation and related matters. Respondents who do not perform audiometry tend to be uncertain in their evaluation of it, regard it as a propaganda or educational device though not strongly so, regard it as not necessary though this tendency is not strong, and feel no cynicism or aggression towards it. Finally, the respondents who stated that they performed audiometry in some companies but not in others tended to evaluate it favourably though not strongly so, were either uncertain of or only slightly in agreement with its necessity, and considered it generally useful to a greater or lesser degree. However, the most important points to emerge from these factor analytic data are that only the evaluative factor discussed earlier established itself in the same form throughout all three groups of respondents, and that the two groups of respondents performing audiometry anywhere at all were favourable to it while the group not performing audiometry was not opposed to it but merely uncertain in its attitude. This suggests that medical officers who perform audiometry in any or all of their companies are not a completely different type of medical officer from those who do not perform audiometry at all, conceiving it in terms of medically different dimensions. Instead the difference appears to be that medical officers who perform audiometry at all have, as a group, made their decision about it while medical officers who do not perform audiometry at all have not made their decision and are exercising caution. This is in accord with the point emerging from the main body of the medical officers' questionnaire and will be discussed further when the conclusions of the whole research project are discussed. The emergence of a single major factor from the factor analyses regardless of respondent group could suggest that medical officers in general tend to regard industrial audiometry not in isolation but as one item in a larger group of occupational health procedures which itself may be a subset of some even larger group. Of course it could also suggest that medical officers simply do not think very much at all about audiometry. It is not unreasonable to think though, that the grander suggestion is the more probable. This being the case, it implies that research into occupational health procedures should be directed primarily at medical officers' perceptions of occupational health as a whole and maybe even at their perceptions of their own role in the field. But this is a matter for further research, as is the more immediate question of what wider group industrial audiometry is a member of inthe minds of industrial medical officers.

7.2 The Workers' Questionnaires

7.2.1 A Mechanism for Increasing the Usage of Personal Hearing Protectors

One of the main hypotheses of the research was that performing audiometry increases the likelihood that hearing protectors, once issued, will be worn. A simple hypothesis but, assuming it to be correct, what would be the mechanism involved? From discussions conducted by the author with those in industry concerned with the problem of hearing conservation it would seem that audiometry is expected to achieve the desired result by either making testees anxious enough to want to protect their hearing or by increasing their awareness of the problem they face. But increased awareness does not necessarily motivate and the effect of increased anxiety is mediated by a string of intervening variables. Belbin (1956a) found that responses to propaganda fell into two distinct types:

(a) recall or recognition of the propaganda, and

(b) subsequent behaviour.

In a follow-up study (Belbin 1956b) she was able to suggest that these response-types were a result of previous learning experiences. Thus an individual who had previously exhibited learning in the form of memorising would respond to propaganda in the same way while an individual who had previously exhibited learning in the form of overt behaviour would be more likely to respond to propaganda by means of behaviour change. Leventhal et al (1965) found that inducing fear was comparatively unimportant compared with specific instructions on what to do although a certain level of fear arousal was necessary for instructions to obeyed. Piccolino (1966) found tht fear was a useful motivator, but only if a person could get rid of the fear immediately by carrying out the instructions on what to do. He found that the greater the fear or anxiety induced the easier the instructions needed to be otherwise a rejection of the message contained in the propaganda would occur. Thus the more anxiety is induced the simpler should be the steps needed to reduce it otherwise the individual will simply reduce anxiety internally by denying the information which caused the anxiety and all will be lost. Thus it follows that it is not enough to merely increase anxiety, the remedial measures must also be outlined and be seen to be readily available. In addition they must be seen to be acceptable and appropriate. So in the field of hearing conservation, awareness of the dangers of hearing-loss must be inculcated, the remedial measures outlined, and their ease of obtaining ensured and the measures must be acceptable. If audiometry can be associated with these requirements then a case can be made for its having an important role to play in hearing conservation.

7.2.2. The Respondents' Perceptions of Audiometry

The results from the workers exposed to audiometry suggest that they perceive it as being a sign of the management's concern for their hearing, that it increases their awareness of their hearing and it is appropriate at work. However there is in their minds room for suspicion of management's motives for doing audiometry and upon this point they reserve their judgement. In the cases of the workers not exposed to audiometry the factor structure is not so clear-cut and there appear to be differences between the workers provided with hearing protectors and those not. The factors extracted do not stand up very well to different modes of analysis, probably because workers not exposed to audiometry have to think of it in more abstract and nebulous terms than do workers who have been exposed to it. Therefore, all that can be done is to see the type of factor that is emerging. Both non-audiometry samples tended to perceive audiometry as useful and appropriate or, at least, acceptable at work but both samples appear to perceive it in terms of industrial relations or financial considerations (i.e. as a job for which there should be a rate) or in terms of its effect upon their jobs. The major difference between the sample using hearing protectors and the sample not is that the former tend to perceive audiometry as a device for increasing awareness of hearing and associated problems while the latter perceive it more as an anxiety-inducing device.

7.2.3. The Respondents' Perceptions of Personal Hearing Protectors

Both samples provided with personal hearing protectors perceive them in terms of their general usefulness, their effect upon personal appearance, their acceptability as regards comfort and hygiene and so on, the freedom of choice workers have to wear them or not, and whether or not the employer is responsible for protecting hearing. Both samples agree that hearing protectors do not spoil personal appearance but they disagree that hearing protectors are not necessarily useful. They both feel that the wearing of hearing protectors should be voluntary and they are both somewhat equivocal about the acceptability of hearing protectors. One major difference between the two samples appears to be that the sample receiving audiometry asks the question, "are hearing protectors useful?" and decides not necessarily so, while the sample not receiving audiometry asks the question, "are hearing protectors useless?" and decides no. Another major difference is that the sample receiving audiometry do not regard management as being responsible for protecting hearing while the sample not receiving audiometry do. Also those workers exposed to audiometry tend to consider hearing protectors in terms of their usefulness to the hard of hearing while the other workers in the study do not. Even though the two rotations of factors used give conflicting scores on this factor, it is still additional evidence that audiometry increases awareness of hearing problems. The overall impression given by these differences is one of a more active evaluative approach to hearing protection amongst the workers exposed to audiometry contrasted with a more passive indifferent approach on the part of the workers not exposed to audiometry.

The third sample, namely the workers receiving neither audiometry nor hearing protectors tended to regard hearing protectors as a necessary form of largesse provided by management but the wearing of which should be voluntary. They appeared to be equivocal over whether they had any control over hearing loss or whether management was responsible for preventing it but they agreed that they should be involved in the issue. They were not sure about the acceptability of hearing protectors but they were agreed (though not strongly) that hearing protectors are masculine. Thus it would seem that although the acceptability of hearing protectors may not change very much, audiometry is associated with an improvement in the ability of workers to become involved in the issue and evaluate it.

7.3 The Hearing Protector Surveys and Detailed Interviews

7.3.1. The Hearing Protector Surveys

Whether or not the number of workers wearing hearing protection is improved by providing audiometry is another matter. Table 49 and Figure 2 suggest that audiometry is associated with a higher acceptance rate but the fact that this is not a necessary result (of Firms A and C) warrants a closer look. None of the firms not providing audiometry, that is Firms B, C, D and H encourage the use of hearing protectors with anything more than posters (and Firm B not even that at the time of the survey) although Firms D and H provide talks for Trade Union representatives. Firm A, which performs audiometry, was similar to Firms D and H. Firms E, F and G, which all perform audiometry, all insist that a strict example be set by supervisory and managerial staff in the wearing of hearing protectors. Firm E also provided direct discussion between management and workers on the issue, Firm F provided this for new entrants as well as closely involving workers representatives in discussions on noise policy and providing instructional talks and showing films, while Firm G was similar to Firm F apart from the films and the courses for new entrants. Thus it may be that a more intense programme of education on noise may be responsible for the higher acceptance rates and that the association between this and audiometry may be coincidence rather than cause and effect.

7.3.2. <u>The Detailed Interviews</u>

If we look at the five detailed interviews reported at the end of the results section we see that no major differences exist between them although the audiometry programmes run by companies A1 and A2 differ considerably. The intensity of action taken against noise by the companies is broadly the same as measured by the question asked even though the products of the five companies vary widely. The noise levels and hearing conservation programmes employed are similar and so these particular results fail to show a link between audiometry and a greater intensity of action against occupational hearing-loss.

7.3.3. Limitations of the Data

However, the strongest impression to emerge from these data is that they fail to demonstrate anything of value to the hypotheses under test. There are two major reasons for this. The first is the size of the samples used and the second is the number of variables bearing upon the problem.

The questions asked in the detailed interviews conducted with the five companies mentioned were based upon possible confounding factors suggested by the various people talked with during the early exploratory stages of the research. It became clear that a number of factors other than the presence or absence of audiometry might affect the usage of personal hearing protectors and that these factors should be taken into account in any study. It was suggested that the level of noise to which workers are exposed will affect the proportion of them that will wear personal hearing protectors. It was suggested that factors which affect the comfort of personal hearing protectors will similarly mediate. Such factors include the temperature, humidity and amounts and types of airborne dust present in the workplace. The type of work being done by the workers may affect hearing protection usage either directly in some practical sense or indirectly in some way such as modifying attitudes towards personal protection generally. The method by which workers obtain personal hearing protectors may be important in that it affects the perceived ease or difficulty of obtaining them. The instructions given on using such protectors may affect their use as may the number of types of personal hearing protectors available (i.e. by increasing the likelihood that acceptable protectors may be provided and by allowing the worker some freedom of choice). These last three variables may interact with each other in some way. The type of programme undertaken by a company to encourage the wearing of personal hearing protectors may be important as may the type of example set by supervisory staff and the number and type of personnel dealing with various aspects of safety and health at work and the money and powers at the disposal of these people. The size of the company may be important. The immediately preceeding variables are obviously related to size but there may be a main effect intrinsic to size (or lack of it) per se. The presence or absence of compulsion may be important and, if it is present, the manner of that compulsion may be important too. The personalities of key people may play a major part in any particular case. There are probably many other variables which may affect the usage of personal hearing protectors, once they are issued. Meanwhile, in the midst of this welter of possible explanatory variables we have audiometry.

But even here the picture is not so simple because the overall manner of audiometric testing may vary between companies doing it. The type of audiometry performed (i.e. manual or automatic) may be important. The time intervals between tests may make a difference as may the question of whether or not tests are performed at particular significant times in a worker's employment and the reasons for which the medical department feels it is doing it. Other factors may be important mediators of whatever effect audiometry may have upon the wearing of personal hearing protectors, such as arrangements that are made for ensuring that testees are not exposed to noise immediately prior to the test and whether or not testees are told the result of the test. The person who tells testees to wear personal hearing protectors may play a part as may the criteria used for selecting workers for testing. Who does the audiometric testing, whether the audiometry programme is new or well-established and the source of the decision to initiate such a programme may all influence the amount of effective effort put into a programme of audiometric testing. Once more, other variables may warrant consideration.

It is obvious that a direct study of the effect of audiometry on the wearing of personal hearing protectors involves the control of a large number of possibly confounding variables. However, in a field study such variables can rarely be adequately controlled, only assessed. Such assessment necessitates the use of a very large sample of companies. Such companies must also be comparable or at least fall into types within each of which companies are comparable. This is an impossible goal when one considers the number of variables for which control is necessary and the number of other ways in which it is possible to conceive of companies varying. Apparent matches may also be open to doubt. For example can a noisy section containing 50 men in a company employing 10,000 people be equivalent to a similar section containing 50 in a company employing only 60 people or are the psychological climates different? Is there a significant sex difference? It is a sobering thought that what has been discussed so far assumes the complete and absolute co-operation of companies approached in supplying the information sought, allowing it be gathered or even simply agreeing to participate in the research at all.

7.3.4. The Importance of Company Co-operation in a Research Programme

This is probably the most crucial problem of all and it certainly plays a large part in explaining the inadequacies of the data that have been presented. It is true that a very large sample of companies would be required and it is true that a large number of observations of hearing protector wearing would be required to obtain a statistically adequate estimate of personal hearing protector usage (work-sampling in other words) but the unwillingness of companies to co-operate fully certainly ensured that my samples would be disappointing. Companies varied in the amount of quality of the information they supplied, hence all the cells in Tables 50 and 51 containing the words "not available". Moving about workplaces unescorted by a safety officer or production supervisor or such-like was not permitted. Thus the collection of more than a few samples of the incidence of personal hearing protector wearing was not practicable owing to the inconvenience to the company of providing an escort. Noise levels have not been included in Table 49 because in some companies taking sound level readings was allowed by the company, in others the results of the company's own survey were provided, while in others neither of these things occurred. Hence it was pointless including noise level readings in the table even though it has been argued that noise levels are important data. The impression was gained that at noise levels approaching 110 dB(A) there existed a threshold below which the proportion of the exposed population wearing personal hearing protectors might be expected to be small while above it this proportion might be expected to be relatively larger all else being equal. This may be related to the threshold of pain. This cannot be substantiated at all though.

7.3.5. The Failure of Direct Methods of Research to Answer the Pertinent Questions

Thus these particular data fail to demonstrate anything other than the inability of direct methods of research to provide answers to the questions asked in the introduction, for the other direct methodology reported - the reliability studies reviewed earlier - is little more than tangential. As a result, it would seem that indirect methods, such as attempting to examine the attitudes of the people involved in all aspects of audiometry and hearing protection are to be preferred. Examination of the data obtained from the questionnaires given to workers demonstrates that the approach is capable of throwing light upon many of the variables mentioned earlier in this section that would need to be controlled for in a direct observational study. For example perceived freedom of choice turns out to be a factor worthy of consideration while personal appearance seems to be important and is not a variable that can be studied in anything but an attitudinal way of some kind. This is a point which will be taken up again in later Chapters.

7.4 Summary of Chapter 7

1. The results of the medical officers' questionnaire were discussed, firstly in terms of the general data obtained, and, secondly, in terms of the factor analyses of the data arising from the attitude part of the questionnaire.

2. A possible mechanism by which the usage of personal hearing protectors might be increased was described.

3. The analyses of the data from the workers' questionnaires were discussed in terms of the perceptions, by workers, of both audiometry and personal hearing protectors.

4. The personal hearing protector survey and detailed interview data were discussed and it was shown that too many confounding variables existed for these data to throw much light upon the hypotheses being tested.

5. The importance of company co-operation was discussed.

6. It was concluded that direct methods of investigation, such as the personal hearing protector surveys and detailed interviews, were of little value in studying questions of the sort being studied by the present research owing to the extreme difficulty of adequately controlling the large number of confounding variables involved. It was argued, instead, that research must proceed by indirect methods, that is, by examining the attitudes and perceptions of all the people involved in the issue being studied.

SECTION IV: CONCLUSIONS AND GENERAL DISCUSSION

CHAPTER 8

CONCLUSIONS

8.1 Resumé of the Hypotheses

In outlining the conclusions it is helpful to relate them to the hypotheses being tested and to indicate the degree of confidence which can be placed in each. A fuller consideration of this matter and the implications of the conclusions for the research area in general will be undertaken in the discussion section which follows the summary of the conclusions.

To reiterate, there were three main and six subsidiary hypotheses being tested. The three main hypotheses were:-

1. Performing audiometry increases the probability that hearing protectors, once issued, will be worn.
2. Audiometry is considered by workers to be evidence of their employer's concern for their welfare.
3. Audiometry is associated with common law claims by workers against employers for alleged occupational deafness.

The six subsidiary hypotheses were:-

1. Audiometry increases workers' awareness of their hearing and of the existence of hearing-loss.
2. Audiometry increases workers' fear of hearing-loss.
3. Audiometry is associated with personal hearing protection as opposed to noise control at source.
4. Industrial medical officers performing audiometry favour personal hearing protection over noise control at source.
5. The priority placed by industrial medical officers performing audiometry upon the prevention of occupational deafness differs from that placed

upon it by industrial medical officers not performing audiometry.

6. Medical officers who perform audiometry are more likely to conceptualise audiometry in terms of its value in litigation or compensation claims made by workers for alleged occupationally-induced hearing-loss than are medical officers who do not perform audiometry.

8.2 Summary of Conclusions

The order of these conclusions is that of the hypotheses to which they relate.

1. Audiometry is associated with a higher incidence of personal hearing protector usage amongst workforces to which personal hearing protectors have been issued.

   This conclusion refers to main hypothesis 1 but cannot be stated with any degree of confidence.

2. Audiometry is perceived by workers as being evidence of their employer's concern for their welfare.

   This conclusion refers to main hypothesis 2 and can be stated with confidence.

3. Audiometry is associated with common law claims against companies for alleged occupationally-induced hearing-loss.

   This conclusion refers to main hypothesis 3 and can be stated with a high degree of confidence.

4. Audiometry inculcates amongst workers a greater degree of awareness of hearing problems.

   This conclusion refers to subsidiary hypothesis 1 and can be stated with confidence.

5. Audiometry does not inculcate amongst workers a greater degree of fear of hearing-loss.

> This conclusion refers to subsidiary hypothesis 2 and can be stated with a fair degree of confidence.

6. Of the five hearing conservation programmes looked at in detail, audiometry is not associated with a greater or lesser intensity of action taken against the problem of occupational deafness.

> This conclusion relates to subsidiary hypothesis 3 and can be stated with a fair degree of confidence.

7. Hearing conservation programmes containing audiometry also tend to contain a wider range of elements intended to help prevent occupational deafness than do hearing conservation programmes not containing audiometry.

> This conclusion relates to subsidiary hypothesis 3 and can be stated with a high degree of confidence.

8. Medical officers, whether performing audiometry or not, do not have appreciable preference for personal hearing protectors as opposed to noise control.

> This conclusion refers to subsidiary hypothesis 4 and can be stated with a fair degree of confidence.

9. Audiometry is not associated with the priority placed by medical officers, whether performing audiometry or not, upon the prevention of occupational deafness compared with that placed upon preventing a selection of other occupationally-induced injuries or disorders.

> This conclusion refers to subsidiary hypothesis 5 and can be stated with a fair degree of confidence.

10. No strong evidence* has been adduced to support the hypothesis that medical officers who perform audiometry are more likely to conceptualise it in terms of its value in litigation or claims for compensation made by workers for alleged occupational deafness than are medical officers who do not perform audiometry.

> This conclusion refers to subsidiary hypothesis 6 and can be stated with a high degree of confidence.

11. Medical officers performing audiometry tend to show a less cautious attitude to it than do medical officers not performing audiometry.

> This conclusion does not relate to any of the research hypotheses, but can be stated with a fair degree of confidence.

12. Audiometry encourages an active, evaluative approach to personal hearing protection on the part of workers as opposed to a passive, indifferent approach.

> This conclusion does not relate to any of the research hypotheses, but can be stated with a fair degree of confidence.

In the discussion of these conclusions that follows, this order is not maintained. Instead, the order used is that which seemed to make the discussion easiest and most useful from a holistic point of view.

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* The medical officers questionnaire produced a strong emotional response on the part of some in the target population. (See Appendix 4 for an example). This hampered data collection and highlighted the sensitivity of this area of research. A note of caution must therefore be sounded for researchers wishing to undertake similar work in this area as regards the difficulties which may be encountered.

8.3 Discussion of the Conclusions

8.3.1 Conclusions 3 and 10

The third conclusion supports one of the three main hypotheses being tested by this research, namely that audiometry is associated with common law claims against employers for alleged occupational deafness. This conclusion is the result of data gained from the medical officers questionnaire, data which supported the hypothesis strongly. Thus confidence can be placed upon this conclusion. This definitely suggests that audiometry plays a non-medical role. Whether audiometry is a cause or an effect of litigation or whether it is more useful to employer or employee in such circumstances cannot be said from this research, but the salient point is that one of the possible uses of audiometry is a non-medical one. This has important implications for the role of the industrial medical officer because he has to decide whether or not he should be using his knowledge and skills in a medical context or a financial one. This is particularly relevant to conclusion number ten which is that no strong evidence has been found to suggest that medical officers who perform audiometry think of it in litigation-oriented terms. In fact, litigation-oriented factors did emerge from the factor analyses of the medical officers' attitude questionnaire, but with insufficient consistency to justify any other conclusion. This suggests that medical officers are aware of the possible litigation aspects of audiometry, but the impetus behind these aspects originates elsewhere. This being so, then medical officers who perform audiometry may be passively allowing themselves to be employed, in this area, for a non-medical purpose, or even rationalising their way around it, in order to solve their loyalty dilemma. This is not to suggest that medical officers who do not perform audiometry are facing down the dilemma and reaching an active decision because there is equally sparse evidence for their conceptualisation of audiometry in terms of its litigation possibilities. These two conclusions are probably of major importance.

8.3.2. Conclusions 2 and 12

Conclusion number two is that audiometry is perceived by workers as being evidence of their employer's concern for their welfare. This is based upon the factor analyses and rotations of the resulting factors from the questionnaires given to workers. This particular factor emerged persistently in one form or another and this can be taken as fairly strong evidence of its existence in reality. Thus this conclusion can be stated with some confidence. The major implication of this conclusion is that workers do not necessarily regard their employer as "the enemy" and that they are prepared to perceive altruism on the part of their employer. It also implies, though, that there is room for manoeuvre when managements are trying to introduce ostensibly beneficial practices for ulterior motives. In this particular case, however (occupationally-induced hearing-loss), this danger is probably minimal because of conclusion twelve, namely, that audiometry encourages an active, evaluative approach to hearing protection. Thus workers are in a better position to reach a reasoned decision upon hearing protectors. Conclusion twelve cannot be stated with any great force as it results simply from the author's interpretation of the "tone" of the factors extracted from the analyses performed on the workers' questionnaire data but it is supported by the fact that the samples exposed to hearing protection perceived it in terms of its value to someone or other while the sample not exposed to hearing protection perceived it in more inconsequential terms such as effect upon personal appearance, masculinity, and so on.

8.3.3. Conclusion 1

This particular net can be spread further to include conclusion number one, which is that audiometry increases the likelihood that hearing protectors, once issued, will be worn. This derives from the remaining main hypothesis being tested by this research by means of the hearing protector use surveys, but, unfortunately, the conclusion can be stated only tentatively owing to the difficulty of saying whether the audiometry was the key factor in producing the effect or whether the propaganda and/or training that accompanied it was more important. But an attempt will be made to try and shed some light upon this matter below.

8.3.4. Conclusions 4 and 5

The fourth and fifth conclusions were, respectively, that audiometry increases awareness (amongst workers) of hearing and problems associated with it, but does not increase fear of hearing-loss. In fact, this latter factor did emerge in one analysis of the workers' questionnaires, but not in others and the overall impression seems to be that these two hypothesised factors are in fact one with "awareness of hearing" being much closer to the true name of it rather than "fear of hearing-loss". Thus, it would appear that audiometry causes workers to consider hearing-loss but not to develop any great anxiety over it. Now it may be recalled from earlier in the thesis that anxiety has been shown to be a mediator of acceptance or non-acceptance of a suggested safety procedure. This anxiety does not appear to be present in the case of audiometry, yet audiometry appears to be associated with increased usage of hearing protectors provided. This suggests, by a process of exclusion, that the propaganda, training and so on were perhaps the key factors. This does not amount to proof, of course, but it enables, taken in conjunction with the other data from the workers part of the study, a model to be devised to explain the effect of audiometry.

8.3.4.1. A Model of the Effect of Audiometry upon Workers

Audiometry causes a greater degree of awareness of the problem of industrial deafness. It causes workers to consider something they had probably not considered previously. On the basis of the facts available to them they conclude that doing audiometry shows that management is concerned for their hearing to such an extent that workers are prepared to consider remedies for the problem of industrial noise more rationally. As a result, they become more amenable to training and propaganda presented in the form of information. In short, audiometry creates the awareness and the interest while propaganda and training takes over on this basis and does the rest. This would appear to fit the findings of Leventhal et al. (1965).

This model, if a reasonable representation of reality, has important ramifications. One is that it assumes that workers are thinking entities and not affective material for the physician or manager or psychologist to mould according to need. The anxiety model ignores the reasoning capacity of the worker and reduces him to a low level of mentality. In a sense it is an insulting model if applied to all attempts at persuading workers to do or to accept something. It is the opinion of the writer that many of those working on the "other side" of industry, that is, medical officers, managers, and so on, do not hold the worker in very high esteem and that this view of the worker is the derivation of the statement that audiometry is seen by workers as an expression of their employer's concern for their welfare. Yet the truth of the matter is probably that the statement is true not because this view of the worker is correct, but because workers see no reason to think otherwise of their employer. After all, there must be some reason why audiometry is being done. Given a different set of facts, such as access to conclusion number three of this research, and they could easily change their perception. Another ramification is that it suggests that two models are necessary according to whether the issue of concern is an emotional one or not. The anxiety model, is based upon sound work, but in what are probably emotionally-charged areas, such as road accidents (Belbin, 1956 a & b) or falls (Piccolino 1966). Hearing loss however, is not considered by workers to be a very important area of concern compared to other possible occurrences in a factory and so does not arouse any great deal of emotion (as evidenced by conclusion five). This is probably analogous to the study of Leventhal et al. (1965) in which the target behaviour was that of coming forward for tetanus inocculations - possibly not an emotionally-charged area as far as most people are concerned. Thus information becomes of greater importance. The motivation, which the anxiety model explains so beautifully, can then be injected later by a well-considered programme of training and informative propaganda.

8.3.4.2. The Perception of Workers by Managements

Evidence to support the contention that managements tend to regard workers in a disdainful manner (consciously or otherwise) can be drawn from Levinson (1973). He does not discuss worker -management relations as such but instead concentrates upon the efforts of managers to motivate their subordinates, whether workers or lower ranking managers, in various contexts. His work has centred upon U.S. industry but he has identified a model of industrial management which he calls the "great jackass fallacy". This fallacy is that the subordinate is likened unto a jackass which can be motivated only by dangling a carrot before the front end while being ready to beat the rear end with a stick when necessary. Levinson goes on to say:

> "the characteristics of a jackass are stubbornness, stupidity, willfulness, and unwillingness to go where someone is driving him. These, by interesting coincidence, are also the characteristics of the unmotivated employee. Thus it becomes vividly clear that the underlying assumption which managers make about about motivation leads to a self-fulfilling prophecy.

> "People inevitably respond to the carrot-and-stick by trying to get more of the carrot while protecting themselves against the stick".

As a result, he suggests that managers should treat all whom they deal with as human beings, a sentiment echoed by Sirota and Wolfson (1973).

To use one last quotation from Levinson (1973):

> "...unconsciously, the boss is the manipulator and controller, and the subordinate is the jackass."

A corollary of attempts to manipulate workers is the attempt to "sell" to workers ideas and schemes which management would like to see used. Hearing protection falls into this category. Indeed, one of the two internal company surveys on the use of hearing protection mentioned in the "Problems emerging from the literature review" section has this to say as its first conclusion, "Operators not wearing protection have not got the message. This could be due to the company not using the right technique for getting the message over." This is another mode of thinking upon which to base the claim that audiometry persuades workers to wear the hearing protection provided. Thus, audiometry can be seen as a focus for some of the diverse aims of management and industrial medical officers. Incidentally, it may also explain why it was found, during the course of the present research, that industrial medical officers were not always the prime movers in trying to establish an audiometry programme. Often the prime mover would be a safety officer or, occasionally, some other type of manager.

8.3.4.3. The Importance of Information

It has been concluded that any approach aimed at persuading workers to wear hearing protection must be an informative one in essence. The importance of information as opposed to pure persuasion has also been discovered in a different context from the present one, namely, commercial advertising. Lambin (1975) evaluated the impact of advertising in an economic context and so most of his conclusions are not relevant to the present discussion. However, his final conclusion was that:

> "Consumer buying behavior (sic) is more rational than advertisers assume. In advertising-intensive markets, consumers respond more readily to copy that incorporates tangible selling propositions than they do to purely persuasive advertising. This kind of response suggests that factual and informative advertising content is welcomed in consumer markets, precisely the point stressed by the consumerism movement."

The degree to which generalisations can be made between Lambin's research and the present is obviously limited, but it suggests that there is a widespread readiness to see any "selling" exercise as a more persuasive than informative one. If, as has been argued, hearing protection is perceived as something which must be "sold" to workers then this particular bias is one which must not be ignored. Thus it is vital for managements to perceive workers as having views worthy of serious consideration.

8.3.5. Conclusions 7, 8 and 11

One of the other subsidiary hypotheses of this research was that medical officers performing audiometry tend also to favour personal hearing protection as opposed to noise control at source. Conclusion number eight refutes this. But this can probably be linked to conclusion seven which was that audiometry tends to be associated with hearing conservation programmes containing a wider range of elements intended to help reduce the incidence of occupational deafness. Both these conclusions can be stated with some confidence. Thus medical officers performing audiometry may favour personal hearing protection more than do medical officers not, but this effect may be a result of medical officers who perform audiometry favouring most or all hearing conservation programme elements more than do medical officers who do not perform audiometry. This may occur because audiometry is performed by large companies which are the only ones with the money to do it and which may therefore be in a better position to afford money for all other aspects of a hearing conservation programme. No evidence has been presented on this point, but it seems likely that this is not necessarily the case as is shown by the fact that organisations, such as the National Association of Drop-Forgers and Stampers (NADFS), exist which provide an audiometry service for their members, most of which are small companies. Thus audiometry is not, of necessity, related to the size of the company. Also, conclusion eleven suggests that medical officers who perform audiometry tend to have a different outlook from medical officers who do not perform audiometry. Like conclusion twelve, conclusion eleven is simply the author's interpretation of the "tone" of the data and so cannot be accepted with any great confidence, but if true it suggests that medical officers performing audiometry are more likely to "jump on the bandwagon" than are medical officers not performing audiometry and are likely to give less consideration to their actions in the process. Thus they may be more likely to favour other elements of a hearing conservation programme as well for the same reasons. The medical officers who do not perform audiometry seem more content to wait until all the evidence is available in the field of occupational deafness before committing themselves. So we may have, in microcosm, the dichotomy between the scientific and the intuitive approaches only in this case exemplifying the worst evils of each. The major fault of the scientific approach is its ultra-conservatism, possibly exemplified here by the reluctance to grasp that which is useful, while the major short-coming of the intuitive approach is its failure to always fully appreciate consequences, possibly exemplified here by the willingness to grasp the useless. But it must be reiterated that the conclusion which is being argued from is only tentative and so this reasoning may approximate speculation more closely than informed discussion.

8.3.6. Conclusion 9

Conclusion number nine is a failure to verify the hypothesis that audiometry is associated with the priority placed upon the prevention of occupational deafness compared with that placed upon the prevention of certain other occupationally-induced injuries and disorders. This conclusion can be stated with confidence being based as it is upon medical officers' questionnaire data which yielded no differences in the priorities assigned to any of the nine occupationally-induced injuries or disorders given between any of the three group comparisons made. This suggests that regardless of their opinions as to the merits or demerits of a particular remedy or medical test, medical officers are as one as to the importance to be attached to preventing suffering and disability. Indeed a large number of respondents refused to answer the particular question on the grounds that, in terms of necessity for prevention, it was impossible to distinguish between occupationally-induced disorders or injuries. This indicates that medical officers think of such priorities in terms of ideal considerations rather than in terms of practical constraints such as resource allocation. This could be because they are all idealists or because they cannot see anything backed by enough evidence to justify spending money on it rather than on anything else, or maybe a mixture of both (keeping conclusion number eleven in mind).

8.3.7. Conclusion 6

Finally, conclusion number six was that, of the five hearing conservation programmes looked at in detail, audiometry was not associated with any greater or lesser intensity of action taken against the problem of occupational deafness. This conclusion is essentially meaningless for reasons discussed in an earlier section.

8.3.8. Summing-up

Industrial audiometry appears to influence the acceptability of hearing protectors indirectly via the avenue of heightened interest and hearing awareness, it is performed by companies in association with common law considerations, it is performed by medical officers for reasons that are, at least in part, intuitive and the result of extraneous pressure, and it is assodated with a more comprehensive type of hearing conservation programme. The role of audiometry in industry appears to be that of catalyst for the workers, protector to the management, and vehicle for personal enthusiasms of the medical officer.

8.4 Discussion of the Conclusions with Reference to the Validation of Medical Screening Procedures

8.4.1 Preamble

The next thing that needs to be determined is which of these conclusions are significant in something other than a merely statistical sense. To some extent this has been touched upon in the earlier discussion but the time has come to extract the essence of the findings of this research project. This means evaluating the conclusions in the light of questions posed in the Introduction to this thesis and arising out of the literature review. In particular, this entails discussing them with reference to the earlier discussion of medical screening procedures.

8.4.2 The Motivational or Attitudinal Validation Criteria

It was proposed that in addition to the biological and economic criteria for validating medical screening procedures outlined by McKeown (1968) there exists a third type of criterion which was called motivational or attitudinal and that this criterion was of equal importance to the other two. It was made plain that industrial audiometry has not so far been shown to satisfy the first two criteria but the emphasis of the present research has been upon establishing its ability or otherwise to satisfy the third. It was argued that a medical screening procedure must:

a. be acceptable to the recipients of that procedure;

b. lead to an acceptable "treatment" for the abnormality in question; and

c. be accepted or rejected for reasons other than prejudice or bias on the part of those who make the decisions concerning the use or otherwise of the procedure.

These conditions apply to industrial audiometry.

8.4.2.1. <u>The Acceptability of Audiometry to its Recipients</u>

With regard to the acceptability of audiometry to its recipients (workers), it can be said that audiometry is quite acceptable to them. The relevant conclusions are conclusion 2 (audiometry is perceived by workers as being evidence of their employer's concern for their welfare), conclusion 4 (audiometry inculcates amongst workers a greater degree of awareness of hearing problems), and conclusion 5 (audiometry does not inculcate amongst workers a greater degree of fear of hearing-loss). The confidence with which these conclusions can be expressed has been discussed earlier, but it can be seen that conclusion 2 is a plus for the acceptability of audiometry to workers, while neither conclusion 4 nor conclusion 5 can be considered a minus.

8.4.2.2. The Acceptability of the "Treatments" Implied by Audiometry

What of audiometry's leading to acceptable "treatment" of noise-induced hearing-loss? Here the issue is more complex. The major relevant conclusions here are conclusion 1 (audiometry is associated with a higher incidence of personal hearing protector usage amongst workforces to which personal hearing protectors have been issued), conclusion 8 (medical officers, whether performing audiometry or not, do not have any appreciable preference for personal hearing protection as opposed to noise control), conclusion 7 (hearing conservation programmes containing audiometry also tend to contain a wider range of elements intended to help prevent occupational deafness than do hearing conservation programmes not containing audiometry), conclusion 12 (audiometry encourages an active, evaluative approach to personal hearing protection on the part of workers as opposed to a passive, indifferent approach), and conclusion 6 (of the five hearing conservation programmes looked at in detail, audiometry is not associated with a greater or lesser intensity of action taken against the problem of occupational deafness). The earlier discussion of the low degree of confidence attachable to the effect of audiometry upon the likelihood of increased hearing protector usage is, in a sense, irrelevant because, as was argued earlier in this thesis, increasing the usage of personal hearing protectors is of little value unless this increased usage encompasses a large majority of the population supplied with such protection. The data that have been collected or reported on are equivocal as to the ability of audiometry to increase hearing protector usage to this extent. Audiometry thus cannot be said to pass this test of its value as a medical screening procedure.

There are two possible reasons for this. The first is that the role of industrial audiometry in this particular area has been misjudged to the extent that audiometry is not a simplistic propaganda device but, instead, a creator of awareness and a disseminator of knowledge to a workforce capable of thinking for itself. This is supported by conclusion 12 (and also by conclusion 4 mentioned in an earlier context) and has been extensively discussed earlier. (The implications of conclusion 12 will be taken up again in the section on indications for further research). The second possible reason is that perhaps the treatment implication of industrial audiometry has been misinterpreted in that conclusion 8 was that no great majority of industrial medical officers, whether performing audiometry or not, favours personal hearing protection over noise control. Yet the interpretation of the relationship between personal hearing protection and audiometry was based upon the review of the literature and upon the interviews with relevant parties in industry. So where was the mistake made? It was mentioned earlier in this thesis that one of the suggested outcomes of audiometric examinations is the removal of individuals who are being affected by noise to quieter jobs. This, after all, is one of the reasons for trying to identify noise-susceptible individuals. It was also mentioned that because of possible legal, industrial relations, and financial problems arising out of the compulsory transfer of noise-affected workers, this is not being done. The finding of the present research that workers value freedom of choice over compulsion in the matter of wearing hearing protectors indirectly supports the prudent nature of not indulging in such activity. It may be, though, that it is more natural to consider prescriptive removal of a noise-affected worker from noise as the "treatment" following from audiometry rather than considering personal hearing protection as such "treatment". After all, hearing protectors can be, and are, issued without the necessity for a test of hearing to be carried out first, and the fact that audiometry tends to be associated with more comprehensive hearing conservation programmes (conclusion 7) may be effect rather than cause. Thus, industrial audiometry fails to meet requirement (b) either because the "treatment" that follows from it cannot be effectively used or because it dare not be used. Neither "treatment" is acceptable enough.

8.4.2.3. The Effect of Decision-Maker Bias

This leads us to the third requirement of a medical screening procedure. All the remaining conclusions (conclusions 3, 9, 10 and 11) are relevant here. Audiometry is associated with common law claims (conclusion 3) but cause and effect cannot be established. Conclusion 10 suggests that medical officers performing audiometry may possibly see it in litigation terms more so than do medical officers not performing audiometry, but this conclusion cannot be stated with conviction. Conclusion 9 suggests that the problem of noise-induced hearing-loss is perceived by industrial medical officers as a medical one just like any other. This is the crux in that medically qualified people are probably predisposed by virtue of their training to see any problem within their field as one involving the identification and treatment of abnormal individuals. Now noise-induced hearing-loss is a problem that may not or need not belong within the realm of medicine (cf engineering solutions), but may be taken on by medical officers because they are predisposed by tradition to regard anything to do with human physical or psychological welfare as coming under their hegemony. It is possible that there are general societal attitudes which uncritically permit this process to occur in a number of instances and that, in the specific instance of noise-induced hearing-loss, managements harassed by various pressures (financial, legal, industrial relations, and so on) to solve the problem are relieved to hand it over, even in part, to the medical people. The difference between those medical officers performing audiometry and those not may simply be the extent to which the two groups are willing to go along with this process. It would seem, therefore, that requirement (c) is not met by audiometry because:

i. noise-induced hearing-loss can be more surely reduced or eliminated by other, non-medical methods, and because,

ii. there may be biasses resulting from the training and/or general attitudes of those participating in the decision to perform audiometry.

8.4.2.4. The Failure of Industrial Audiometry to Satisfy Motivational or Attitudinal Criteria

So does audiometry satisfy the motivational or attitudinal critera for the validation of a medical screening procedure? On one count the answer is yes, but on two counts it is no. The overall answer must therefore be no. The main reason is that industrial noise-induced hearing-loss is a problem more suitable to an approach other than one involving medical screening.

8.5 Outcome of the Research

In the section "Problems Emerging from the Literature Review" it was argued that the biological and economic criteria for validating a medical screening procedure outlined by McKeown were not enough and that a third type of criterion, which was named motivational or attitudinal, is needed as well. The research presented in this thesis has supported that argument.

However, as can be seen in the discussion of the literature review and the discussion of the conclusions, audiometry in industry can be discussed in terms unrelated to its value as a medical screening procedure, as well as in such terms. This leads back to the questions posed in Chapter 1.

The indirect question asked was, "why is audiometry performed or not performed in industry as the case may be?" The discussion of this question has been intensive and shows that the reasons for performing audiometry are not necessarily wholly scientific. This is of great importance when one considers that the hearing ability of many thousands of workers is at stake. The discussion of this question also leads to the answer that direct observational research methods are either irrelevant to or impractical for the examination of the kind of policy question of most interest (i.e. should audiometry be performed at all in industry) and that only an indirect attitudinal type of approach can provide useful information.

The two direct questions asked were "does audiometry provide for the effective protection of every individual worker as opposed merely to groups of workers on a probabilistic basis?" and "should audiometry be performed at all in industry?". The answer to the first question seems to be no. The second question is a question of policy which the data and arguments presented in this thesis cannot answer, only provide guidelines. There certainly appear to be many reasons why audiometry should not be performed in industry if only because there appear to be few reasons why it should. The best reason for performing audiometry in industry, in terms of the support lent by the research reported in this thesis, is that of using audiometry to help create an awareness amongst workers of the problem of noise-induced hearing-loss. This is important but it is not to say that such a result could not be achieved more efficiently or more effectively by other methods.

Finally, one of the outcomes of this research is the suggestion that workers should play a part in decisions concerning safety procedures equal to that played by relevant persons at management level. Of course it could be argued that this already happens or, alternatively, that the roles of managements and workers are dissimilar so that the burden of making decisions must rest more heavily with managements. However, it has been argued in this thesis that, in practice, there is a tendency on the part of managements to think that safety is something that must be "sold" to workers and that resistance is something that must be overcome. The impression of workers implied by this is counter-productive in that an informative as opposed to a persuasive approach may result in worker evaluations which expose genuine flaws in the decisions taken by managers and others. Also it is counter-productive in that if the decision-makers place persuasion before information there is the danger that they may persuade themselves of the correctness of decisions which might not have been made had they thought more in terms of evaluation of information rather than persuasion of others. This is not to say that managers do not think rationally, but simply that there is always the possibility that decision-making processes may contain more intuitive components and rationalisations than is realised and that guard should be taken against them. This is the message that comes through from the discussions of direct versus indirect methods of investigation and from the discussions of the validation of medical screening procedures. Thus, while persuasion always has its place, information should come first - at least in the prevention of noise-induced hearing-loss amongst workers.

8.6 Summary of Chapter 8

1. The hypotheses were re-iterated and the research conclusions summarised. The conclusions were then discussed in terms of what they implied for the hypotheses, that is, the extent to which the hypotheses were supported or otherwise.

2. It was argued that industrial audiometry fails to satisfy the motivational or attitudinal criteria for validating a medical screening procedure in that, while it is acceptable to its recipients (workers), the possible "treatments" implied by it are not necessarily so, and the decision to employ audiometry is not the best that can be made if workers' hearing is to be protected and, in addition, personal biasses, arising from the decision-makers, may play a part.

3. The final outcome of the research, reported in this thesis, was summarised.

CHAPTER 9

INDICATIONS FOR FURTHER RESEARCH

9.1 Perceptions of Safety and Health

One of the most important things to emerge from this research is a glimpse into the void that is our understanding of the interpersonal perceptions extant in the field of Safety and Health. What this means in essence is that few people involved in the field on either the receiving or the providing end of procedures or knowledge or technologies have much idea of what others in the field really think or how they think it. It is crucial that this void should be filled for not only is there scope for wasting money and resources in a sector where waste is a luxury but more importantly human well-being is at stake. So it is absolutely necessary that the thought-processes of safety be investigated with at least as much vigour as the procedures, techniques, equipment and technology. For example, this may throw light upon the suggestion, made earlier, that many medical officers may feel that not enough is known about Safety and Hygiene to justify expenditure on any of its procedures. This may be a result of personality factors, as was also suggested, or it may be simply that the belief is true. If this is the case then it is certainly more than worthy of research effort.

Related to this point is the suggestion made in the text that medical officers as a whole see audiometry not as an individual technique to be evaluated in terms peculiar to itself, but simply as an example of a wider group of techniques and procedures, all the parts of which are evaluated in terms of similar basic dimensions. This being the case, then two possibilities for further research emerge: what is the general set of items to which audiometry belongs in the minds of medical officers, and might it be that medical officers who adopt a particular stance on the question of audiometry are likely to adopt a similar type of stance with regard to other occupational health techniques, procedures and innovations? In other words, are we dealing not with responses to specific items, but with a generalised response set? Both of these areas of further research may throw light upon the relationship between the industrial medical officer and the field he or she practices in, a contribution which may prove invaluable in our attempts to understand and rationalise the processes of decision-making in occupational safety and health.

If we look at this particular problem in a wider context we find we are questioning how medical people perceive their role in society and, in turn,how society perceives their role. It was suggested in the discussion of the conclusions that medical people may see themselves as the natural overseers of attempts to tackle problems relating to human physical and psychological welfare and that society in general may also share this perception. This can have grave consequences if it is true that such problems of human welfare do not require medical solutions necessarily by definition. Thus research into the attitudes of society in general to the medical profession and the medical profession to itself is vital, as is research into the most effective solution to every human welfare problem, such research being unhindered by the assumption that the solution must, by definition, by a medical one.

9.2 Specific Aspects of Hearing Conservation

If we now look at some of the more specific holes left by the research reported in this thesis, it can be seen that a valuable focus for a future research effort would be the nature of the relationship between audiometry and litigation. Does audiometry precede or follow a common law claim or a series of them? Does audiometry save a company money in terms of successfully defended lawsuits or does it cost them money in terms of stimulated claims? The association between audiometry and common law claims has been established, it is now necessary to investigate the nature of it.

Another matter for further research is that of finding the most effective form of training and propaganda programme. There are several facets to this. Should the training of management and safety and health professionals be more widely used so that they can better decide upon what to train the workforce to do? Which programme of training is best suited to capitalise upon the interest in hearing created by audiometry? Is audiometry the best way of creating the necessary interest to begin with? These are all matters worthy of further research.

Indeed, further research is vital because the question now is not whether audiometry has an effect or not for the answer is that it has, albeit not overpowering, but whether the alternatives to audiometry are more effective. With regard to training and propaganda, more direct approaches may have at least as much success as audiometry. Such a direct approach includes lectures given by competent persons to the noise-affected workforce. Various forms of this approach are used already by a number of companies but their success rates have not been compared with those of audiometry. In many audiometric examinations the testee is seen individually by a member of the medical staff and warned of the dangers of noise and hearing-loss. Why not dispense with the audiometry and instead retain the interview in the form of a discussion between the testee and a competent person who need not be medically or para-medically qualified, thus freeing medical staff for other pressing purposes? This approach could be investigated. What effect do films and tape-recordings simulating hearing-losses have upon the behaviour of workers (and managers for that matter)? It may be that here is a very efficient means of creating awareness. What about the simple device of drawing the attention of workers to sounds that they cannot hear but that the competant person alleges he can whilst in the course of an informal conversation? It is possible that this may be more effective than audiometry because, done properly, there could be no suggestion of anyone's attempting to foist anything upon anyone else, thus decisions to act would appear to be internally-generated. On the other hand, this approach may be too facile for credibility, but has anyone looked to be able to say one way or the other? The answer is no. There are probably many other alternatives to audiometry if the aim is to create awareness of hearing problems. All need to be investigated properly if we are to have the most efficient and effective way of achieving this.

If we look at alternatives to audiometry on a more basic level then we are simply asking the question, "why do audiometry at all?" because the answer to it largely depends upon what else could be done were audiometry to be abandoned. The general intention of audiometry is to help prevent workpeople from having their hearing ability impaired through working with or amongst noisy machines or industrial processes by means of identifying hearing-loss when it occurs and taking action of some sort. The objectives of audiometry that have been discussed simply refer to types of action that can be taken and most of the research done upon industrial audiometry refers to the efficiency or ability of audiometry to satisfy these objectives. Now there may be alternative ways of achieving each objective and alternatives for one such objective were discussed in the previous paragraphbut, more importantly there may be alternatives to doing audiometry at all. The most obvious is noise control for if the noise from machines and processes is reduced sufficiently far then occupationally-induced hearing-loss ceases to be a problem and so there is no need to consider audiometry at all. Noise control, however, is often expensive and often technically difficult. However, it is also often cheap and also often technically simple, depending upon the problem. The perceived expense and difficulty of noise control can often lead to a blanket rejection of the approach as ideal but hopelessly impracticable. The successes of noise control give the lie to this assessment and suggest that research may provide worthwhile solutions in many circumstances. After all, the whole of human progress has been a process of overcoming apparently insuperable problems. A "second-rank" solution to the problem of occupationally-induced hearing-loss is the provision of personal hearing protectors. It is here that audiometry comes into its own as an adjunct, supposedly monitoring the hearing conservation programme and educating workers to wear their protectors. This is a result of problems known to exist with assessing the true protection provided by hearing protectors (see the work of Else) and with ensuring that they are worn. The latter problem has been a major concern of the research reported in this thesis in general and the previous paragraph in particular but the former problem is one in which research could provide solutions involving environmental and supervisory monitoring as opposed to biological monitoring, into which class audiometry falls. A compromise personal hearing protection-type solution involves identifying people who are particularly susceptible to noise-induced hearing-loss and protecting them either by insisting upon their assiduous use of personal hearing protectors or by removing them from their noisy jobs. The latter can be a thorny industrial relations problem while the former still involves the problems of ensuring correct usage, though on a smaller scale. More importantly, though, audiometry can never predict hearing-loss in advance, only monitor the speed of its progress. Noise-susceptibility can only be adduced in a post-hoc fashion. Also, if the unrelabilities of audiometry are considered, it may be possible to notice relatively rapid loss of hearing acuity by other simpler means such as simply talking to a suspected noise-susceptible individual. However, a definitive predictive test of noise-susceptibility is not available and so research into development of such a test may eliminate the need for audiometry and other post-hoc tests in this role.

Another matter for research is the relationship between audiometry, hearing conservation programmes and company size. Still another is the relationship between hearing protector acceptability and noise level. A relationship found here might be stronger than any other relationships which might be discovered.

A further matter which may be significant is the fact that no firm could be found which provided audiometry but not hearing protectors. This suggests that companies associate audiometry with hearing protection

in which case, if one reason that companies perform audiometry is in order to protect themselves against common law claims then might not hearing protectors be provided by them for the same reasons? Such a possibility would be well worth examining.

9.3 Definitions in Hearing Conservation Programmes

An additional area which would benefit from further research is that of definitions in hearing conservation programmes. What is meant by the efficiency of a hearing conservation programme? What is an acceptable minimum level of personal hearing protector usage? If routine serial audiometry is carried out, how long are the intervals between tests? One year, two years, four years, three months? How long should they be? What criteria are used for deciding whether a real deterioration in hearing-level has occurred in the interval between two tests? What criteria are the best? What test frequencies should be used? Standardisation is needed in this area.

9.4 The Randomness or Otherwise of Error in Audiometry

It was stated earlier that the reliability of audiometry is not really relevant if group means are being compared for the purpose of monitoring a hearing conservation programme. The assumption here is that the errors of audiometry are random. However, two studies cited in the "Review of the Evidence" section implied that this assumption may not be correct. Obviously research needs to be done on this point in order to avoid the possibility of spurious conclusions being drawn from monitoring audiometry programmes.

9.5 The Screening Aspects of Industrial Audiometry

If we look at screening audiometry it will be recalled that the purpose of any programme of medical screening is to discover a disorder whilst it is still in the pre-symptomatic stage and initiate preventive measures against it. There is also a danger, though, that the pre-symptomatic signs may be regarded as the disorder and action taken accordingly. Thus, to take a common example, an applicant for a responsible job may be discovered to have signs of hypertension and so is refused the job even though he or she has experienced no obvious ill-effects and there is no guarantee that the hypertension will interact adversely with the job. Such an approach is only justified if the link between the pre-symptomatic signs of a disorder and the disorder are so strong as to make disaster almost inevitable if the signs are ignored. In the field of occupational hearing-loss, the disorder being screened out is social disability as a result of impaired hearing. However, studies cited in Chapter 2 suggested that pure-tone audiometry may not be a valid predictor of social disability. If this is so, should we be using pure-tone audiometry (that which is used at the moment) as a screening test or should we search for an alternative? In other words, are the biological criteria for evaluating a medical screening procedure satisfied in the case of screening audiometry or is there a more viable alternative to audiometry? Perhaps we should find out.

9.6 Strategies and Foci of Research in Industry

If we consider the wider context then it seems appropriate to examine the whole of style of research in industry. It has been argued that for the questions pertinent to the area of interest to the research reported in this thesis, direct observational studies are inadequate and that only the indirect method of examining the people involved in the issue can yield information of value. The approach allows us to look at how decisions in the occupational safety and health field are arrived at in terms of one particular way of conceptualising this process (i.e. the psychological rather than the institutional aspects of decision-making). This is vital if we are to know whether the best possible decisions are being made or not. The approach, or extensions of it, allows us to gain some insight into the relationship between the area we are concerned with and other areas which we may not have considered relevant. For example some of the data reported in this thesis suggested that workers do not necessarily conceptualise their management as their enemy. This in turn suggests that such a conceptualisation may affect their thinking on other safety and health matters and further suggests that the realm of industrial relations may be a fruitful area of research in ways other than that of helping management to run their company more efficiently.

This leads on to another aspect of an indirect approach, namely, that it encourages the view of workers as a group of people with independent attitudes at least as important as those of any other group as opposed to viewing workers as objects of study. The current paradigm for industry seems to be that company owners or employees on a management level regard workers as objects who must be "sold" things like types of working conditions, certain safety procedures, certain pay structures and so on if the sellers' lives are to be made easier. The research reported in this thesis has shown that in fact workers evaluate these things according to various criteria just as members of the so-called "other" side of industry do and that a more realistic paradigm might be one of regarding all industrial groups as interacting partners all with attitudes that need to be explored and assessed, accepted or modified on an equal basis. The bipartisan conflict that exists in industry may be nothing more than an epihenomenon created by the ignorance of all parties. This may appear obvious but it can only be demonstrated by examining the attitudes of all parties in industry in order to see if they are reasonable, based upon adequate knowledge, amenable to change and so on, only then can the best possible decisions be made for the benefit of all concerned. All decisions in industry at some stage affect people and so it is vital that major weight be given to the thoughts of people and this can only be done by treating people as the focus of study. Studies of the technical limitations of equipment and techniques are vital but they will not tell us whether such equipment and techniques will be used to best advantage, if at all, or if they are in the best interests of all. To answer these questions we must make people the subjects of our research.

This last point also highlights another problem which seems to have been overlooked. It is traditional in research deriving its data from people in some way to call these people "subjects". However, it seems that the word "subjects" has become confused with "objects" such that subjects are thought of as objects. The terms are not synonymous in that a subject can interact with the observer while an object cannot. This confusion of the two concepts appears to have created a situation in which some groups (such as industrial medical officers, perhaps) consider that they are instigators or observers of research while other groups (such as workers, perhaps) are objects of research, although it is doubtful that they would accept this consciously. This is understandable in that people, as a rule, do not relish the prospect of being the object of the probings of others.

A case in point is the response of some of the industrial medical officers to each of whom was sent a copy of the postal questionnaire. (Indeed, one particular medical officer was incensed enough to write a subsequently unpublished letter to a professional journal on this point. This letter has been reproduced as Appendix 4). Thus such groups may develop a distaste for being the subjects (here confused with objects) of research. This blurring of distinction must be removed because only by the examination of all groups can we arrive at an undistorted picture. In a highly complex human "field" setting, such as industry, the only approach to answering the type of policy and planning question of interest to us that is capable of restoring this distinction is some kind of attitudinal approach.

Now such an approach need not follow the exact lines followed in this thesis. Methods other than the use of questionnaires may furnish more information. Factor analysis may not be the best way of arriving at a picture of underlying percepts. Indeed, factor analysis as a statistical technique and a conceptual tool is the object of some controversy. The validity of results obtained may need careful examination, but it is reasonable to suggest that future research into occupational safety and health (and other matters) in general and audiometry policy-making can only be performed adequately by examining the reasons behind the positions taken by and the behaviours of all the pertinent groups of people - workers, safety officers, medical officers, managers and so on.

9.7 Validation of Medical Screening Procedures

Finally, the whole area of research into medical screening procedures is opened up to further probing now that the existence of a third major type of criterion for evaluating such procedures has been suggested. It may be that economic and attitudinal (motivational) criteria may interact under certain circumstances suggesting that they are both subsets of a single type of "behavioural" criterion. At the present, though , this is in the realm of speculation.

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APPENDIX 1: THE QUESTIONNAIRES

USED IN THE STUDY

APPENDIX 1

Reproductions of the three questionnaires used in the study. First of all the workers' audiometry attitude questionnaire, next the workers' personal hearing protectors attitude questionnaire, and lastly the industrial medical officers' postal questionnaire.

THE WORKERS' AUDIOMETRY QUESTIONNAIRE

1. Conducting hearing tests is the job the National Health Service, not the employer.
2. Hearing tests should not be used to disqualify a person from employment.
3. There is no reason why employees should have their hearing tested at work.
4. Hearing tests done at work are more valuable to managements than employees.
5. Having your hearing tested at work makes you worry about your hearing.
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.
7. The older you are, the more useful it is to have your hearing tested.
8. Hearing tests done at work are useful for some purposes but not for others.
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.
10. The younger you are the more useful it is to have your hearing tested.
11. Hearing tests should be done by your own doctor and not at work.
12. Time spent having your hearing tested at work should be paid at overtime rates.
13. Hearing tests at work encourage people to have medical check-ups they might otherwise not have had.
14. Having your hearing tested at work makes you think about your hearing.
15. The provision of hearing tests is a sign of an employer's concern for the hearing of his employees.
16. Hearing tests at work should be compulsory.
17. Hearing tests at work are necessary.
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.
19. It is every employee's right to have his hearing tested.
20. Hearing tests done at work are useful to both managements and employees.

21. Hearing tests are best left to the National Health Service.

22. There's no point in testing a woman's hearing at work.

23. People should not be paid for time spent having their hearing tested at work.

24. Hearing tests done at work are pointless.

25. Having your hearing tested at work makes you more aware of your hearing.

26. Testing hearing is not a medical problem.

27. Work is just as good a place as any to perform hearing tests.

THE WORKERS' PERSONAL HEARING PROTECTORS QUESTIONNAIRE

1. Earmuffs and earplugs are a bad thing.
2. Earplugs and earmuffs are dirty.
3. Hearing loss at work is unavoidable.
4. Wearing earmuffs or earplugs is a matter of taste.
5. It is never too late to start wearing earmuffs or earplugs.
6. The wearing of earplugs or earmuffs should be made compulsory.
7. There is no point wearing earmuffs or earplugs if you've been working in noise for a long time.
8. It is up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.
9. There is not much point in wearing earplugs or earmuffs if you've got good hearing.
10. Earmuffs and earplugs may or may not be useful.
11. There is no point in wearing earplugs or earmuffs if you've got bad hearing.
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.
13. Earmuffs and earplugs are just as useful to both men and women.
14. People are so used to wearing protective equipment that one more item such as earplugs or earmuffs wouldn't make any difference.
15. Earmuffs or earplugs are not much use if you're hard of hearing already.
16. Earmuffs and earplugs are comfortable to wear.
17. Wearing earmuffs makes you look silly.
18. If a woman goes deaf at work, it is her employer's fault.
19. Earmuffs or earplugs shouldn't be necessary because machines should be made quieter instead.
20. Wearing earplugs makes you look silly.
21. It is too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.
22. An employer is responsible for everything that happens on his premises, including hearing loss.

23. The provision of earplugs or earmuffs is a ploy used to managements to shift responsibility for protecting hearing onto the workers.

24. It is absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.

25. Earmuffs spoil your appearance.

26. If a woman goes deaf at work, it is her own fault.

27. It is absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.

28. Every employee has the right to a pair of earmuffs or earplugs.

29. It is the employer's job to protect the hearing of his employees.

30. When it comes to wearing earplugs or earmuffs, it does not matter what sex you are.

31. Providing earplugs or earmuffs is a sign of the management's concern for the hearing of its employees.

32. It's reasonable to expect men to wear earmuffs or earplugs, but not women.

The ordering of the questionnaire items on these questionnaires was random. To achieve this, each item was assigned a number and these numbers were randomly ordered. The numbers were then converted back to the original questionnaire items to arrive at the questionnaires reproduced above.

THE INDUSTRIAL MEDICAL OFFICERS' QUESTIONNAIRE

1) Are you at present practising Occupational Medicine? Yes ☐ No ☐

If 'no' please proceed no further but return this questionnaire as soon as possible. Thank you very much.

---

2) Are you engaged in Occupational Medicine (a) full-time? ☐

(b) part-time? ☐

If part-time please state the number of sessions per week.................

and number of hours per session....................

---

3) Please state on the table below for each industry or organisation for which you are a medical officer

- (i) the type of industry or organisation.
- (ii) the number of years you have been employed by that industry or organisation.
- (iii) the approximate size of the population for whom you are responsible.
- (iv) the number of other doctors sharing that population and whether they are full or part-time.
- (v) the number of OH nurses assisting with this work-load and whether they are full or part-time.
- (vi) whether a safety officer is also employed.
- (vii) whether an occupational hygienist is also employed.

(i)	(ii)	(iii)	(iv)		(v)		(vi)		(vii)	
Industry etc	No. Years	Pop.	Doctors		Nurses		Safety Off		Occ Hyg	
			FT	PT	FT	PT	FT	PT	FT	PT

4) For each industry or organisation for whom you work, please state on the table below

(i) whether audiometry is performed
(ii) if yes to (i), for how long it has been performed
(iii) if yes to (i), is it performed on a routine or occasional basis
(iv) if yes to (i), on what section of the employed population is it performed (eg everyone, all workers with noisy jobs, etc)

	(i)		(ii)	(iii)		(iv)
Industry etc.	Audiometry Yes	Audiometry No	Time (years)	Routine	Occ.	Section of Pop.

If none of the industries or organisations for whom you work performs audiometry please ignore question 5.

5) Audiometry is performed in industry for a variety of reasons, some of which are listed below. Please look through the list and place a 1 by the main reason for which you perform audiometry, a 2 by the second most important reason and so on down the list. If you do not perform audiometry for a particular reason listed, leave the accompanying box blank.

(a) To screen out individuals for further investigation by either you or by other doctors or specialists. ☐

(b) To provide an occasion for persuading reluctant workers to wear hearing protectors which have been provided. ☐

(c) To assist in the job-placement of individuals who have a hearing loss. ☐

(d) To provide a record of changes in an individual's hearing level. ☐

(e) To detect individuals who may be an accident risk either to themselves or to others because of poor hearing ability. ☐

(f) To detect noise-susceptible individuals. ☐

(g) To practice health surveillance. ☐

(h) To provide a baseline for later comparisons. ☐

(i) To provide biological monitoring. ☐

(j) To provide information which may be useful in any subsequent litigation for alleged noise-induced hearing-loss. ☐

(k) As an essential tool of preventive medicine. ☐

(l) To reduce the strain upon NHS ear, nose and throat departments. ☐

(m) Any other reason/s (please specify). ☐

____

____

____

6) For any of the industries or organisations for whom you are working and in which audiometry is <u>not</u> performed, please say why audiometry is not performed.

____

____

____

____

7) For which of the reasons listed below do you think audiometry is performed by other people in industry? Please rank them in order of importance.

(a) To screen out individuals for further investigation. ☐

(b) To provide an occasion for persuading reluctant workers to wear hearing protectors which have been provided. ☐

(c) To assist in the job-placement of individuals who possess a hearing loss. ☐

(d) To provide a record of changes in an individual's hearing level. ☐

(e) To detect individuals who may be an accident risk either to themselves or to others because of poor hearing ability. ☐

(f) To detect noise-susceptible individuals. ☐

(g) To practice health surveillance. ☐

(h) To provide a baseline for later comparisons. ☐

(i) To provide biological monitoring. ☐

(j) To provide information which may be useful in any subsequent litigation for alleged noise-induced hearing-loss. ☐

(k) As an essential tool of preventive medicine. ☐

(l) To reduce the strain upon NHS ear, nose and throat departments ☐

(m) Any other reason/s (please specify). ☐

8.) In the industries or organisations in which you are employed, is it the policy to

	In all	In some	In none
(a) attempt to quieten existing noisy machinery?	☐	☐	☐
(b) attempt to control noise at the machinery and plant design stage?	☐	☐	☐
(c) insist upon noise-limiting requirements when purchasing new plant and machinery?	☐	☐	☐
(d) provide for employees required to work in "noisy" areas			
(i) ear muffs? if yes, how many types?________	☐	☐	☐
(ii) ear plugs? if yes, how many types?________	☐	☐	☐
(e) control administratively the amount of time spent by employees in "noisy" areas?	☐	☐	☐

9) Have any of the industry/ies in which you are employed

	Yes	No
(a) been involved in common law claims for alleged occupational hearing loss whether these were settled in or out of court?	☐	☐
If yes, how many claims?________		
(b) any common law claims for alleged occupational hearing loss outstanding at the moment?	☐	☐
If yes, how many claims?________		

---

10) Below is a very broad classification of injuries and disorders which can have an occupational origin. Could you please rank them in order of priority as regards their prevention by placing a "1" opposite that item, the prevention of which you feel should have top priority, a "2" opposite the highest priority amongst the remaining items, and so on?

(a) Respiratory disorders. ________

(b) Minor accidental injuries. ________

(c) Occupational cancer. ________

(d) Damage to eyesight. ________

(e) Major accidental injuries. ________

(f) Noise-induced hearing loss. ________

(g) Fire and explosion injuries. ________

(h) Poisoning by toxic metals (as distinct from excessive absorption).________

(i) Dermatitis. ________

---

11) If hearing protectors of any kind are provided by the industry/ies in which you work, does the programme designed to encourage their use employ

	In all	In some	In none
(a) Posters.	☐	☐	☐
(b) Talks given by medical officers.	☐	☐	☐
(c) Talks given by nursing staff.	☐	☐	☐
(d) Talks given by the safety officer or his staff.	☐	☐	☐

(e) Talks given by managers.	☐	☐	☐
(f) Talks given by workers' representatives.	☐	☐	☐
(g) Advisory pamphlets.	☐	☐	☐
(h) Films.	☐	☐	☐
(i) Advice given by medical officers at audiometric testing sessions.	☐	☐	☐
(j) Advice given by nursing staff at audiometric testing sessions.	☐	☐	☐
(k) Other means (please specify).	☐	☐	☐

12) This is a hypothetical question. If you were to be asked to advise a company employing 1,500 people on how to spend a budget allocated to tackling the problem of noise-induced deafness, how would you advise the company to apportion it amongst the options listed below if the budget were (i) £5,000, (ii) £25,000 (iii) £100,000?

	£5,000	£25,000	£100,000
(a) Quietening existing plant & machinery			
(b) Development of methods of quietening existing plant & machinery			
(c) Designing quieter machines			
(d) Carrying out noise surveys			
(e) Providing hearing protectors			
(f) Noise-hazard education programmes			
(g) Encouraging the use of hearing protectors provided (ie. supervision, posters, training courses etc.)			
(h) Audiometry			

13) Do you conduct research in occupational health? Yes ☐ No ☐

If yes, in which area? ____________________

14) Which other medical fields do you currently work in?

	Yes	No
(a) None	☐	☐
(b) General Practice	☐	☐
(c) University	☐	☐
(d) Hospital	☐	☐
(e) Other (please specify).	☐	☐

____

15) Please state the year in which you qualified. 19____.

16) Could you please indicate your age by placing a tick in the appropriate box.

25 to 35	☐
36 to 45	☐
46 to 55	☐
56 to 65	☐
over 65	☐

17) Sex Male ☐ Female ☐

Overleaf is a moderately short attitude questionnaire compiled from statements which have been made about industrial audiometry. I would be most grateful if you could look through these statements and indicate the extent of your agreement or disagreement with each one by putting a tick or a cross in the appropriate box.

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. Industrial audiometry is a useful diagnostic tool.					
2. Audiometry is an essential part of any hearing conservation programme.					
3. Assessing a worker's hearing ability is not necessary in order to protect it.					
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.					
5. Audiometry is not advisable in an industrial situation.					
6. Audiometry has no effect on industrial relations.					
7. Audiometry is an expensive toy for occupational physicians to play with.					
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.					
9. Industrial audiometry is basically anti-worker.					
10. Money spent on audiometry would be better spent on noise control					
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.					
12. Audiometry and noise control are inseparable.					

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
13. Firms should be compelled by law to periodically test the hearing of their employees.					
14. Workers regard audiometry as evidence of their employer's concern for their welfare.					
15. Audiometry can never prevent occupational deafness.					
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.					
17. The value of audiometry in industry is unestablished.					
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.					
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise- induced hearing-loss.					
20. Audiometry is an adjunct to a hearing conservation programme and no more.					
21. Audiometry encourages the use of hearing protectors by workers.					
22. Audiometry encourages managements to take an interest in the problem of noise at work.					
23. Not enough is known about industrial audiometry to make statements about its usefulness.					

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
24. Audiometry and hearing protection are inseparable.					
25. Not many people in industry care very much about audiometry.					
26. No matter what people say, testing the hearing of workers can't do anyone any harm.					
27. Audiometry is relatively inexpensive.					

COMMENTS.

APPENDIX 2: TABLES OF FACTOR LOADINGS

APPENDIX 2

Tables of loadings of each attitude statement upon each significant factor extracted in each principal components analysis and rotation to simple structure thereof. Tables 1 to 12 are derived from the analysis of the workers' audiometry questionnaire, tables 13 to 21 from the analysis of the workers' hearing protectors questionnaire, and tables 22 to 33 from the industrial medical officers' audiometry attitude questionnaire.

Decimal points are omitted and loadings significant at the .01 level are accompanied by an asterisk.

TABLES 1 TO 12

OUTCOMES OF THE ANALYSES OF THE WORKERS' AUDIOMETRY QUESTIONNAIRE

TABLE 1 FIRM 1

PRINCIPAL COMPONENTS ANALYSIS

	FACTOR NUMBER				
ITEM NO.	1	2	3	4	5
1	-36*	-34	-20	45*	14
2	26	-52*	14	22	01
3	-10	-34	-08	13	-13
4	-47*	-38*	-22	-31	-05
5	-09	-55*	-15	-27	-51*
6	-05	-48*	12	13	64*
7	38*	-10	09	23	-03
8	-33	-10	08	10	-36
9	-14	-40*	37*	-09	13
10	47*	-33	08	52*	-20
11	-39*	-43*	-12	37*	-04
12	-30	-24	41*	-13	05
13	20	-36*	-49*	-12	12
14	21	-27	-80*	-03	-01
15	61*	17	-11	06	-04
16	65*	11	16	06	-13
17	49*	18	20	11	-13
18	60*	36*	-10	32	02
19	35*	-25	19	-00	00
20	75*	-22	-03	08	32
21	-62*	-18	09	54*	-02
22	-22	68*	-25	35	00
23	-06	-06	10	24	-44*
24	-63*	31	-12	30	08
25	26	-22	-68*	02	-02
26	-05	57*	-12	04	-03
27	49*	-38*	23	04	-16

TABLE 2 FIRM 1

VARIMAX ROTATION

ITEM NO.	FACTOR NUMBER				
	1	2	3	4	5
1	-09	15	72*	12	11
2	15	11	09	18	18
3	-03	04	22	01	08
4	-25	12	13	14	06
5	-00	22	-05	25	08
6	04	12	20	16	86*
7	52*	-00	-01	00	09
8	-03	-11	11	04	-06
9	08	-22	-02	06	61*
10	43*	15	04	06	09
11	-05	03	75*	13	-01
12	-27	-28	-03	18	40*
13	-05	55*	-04	15	-04
14	09	92*	03	08	05
15	71*	22	-29	-10	-02
16	56*	-04	-26	16	-20
17	23	-18	-22	05	-31
18	54*	07	-04	-07	-32
19	41*	-08	-04	27	05
20	52*	12	-08	15	-08
21	-25	-25	70*	-15	08
22	02	-01	06	-94*	-09
23	06	-05	09	-03	-05
24	-27	-09	47*	-37*	-00
25	04	74*	04	-11	-15
26	-09	-05	-19	-67*	-13
27	14	-01	-12	25	-02

TABLE 3 FIRM 1

QUARTIMAX ROTATION

	FACTOR NUMBER				
ITEM NO.	1	2	3	4	5
1	-11	14	72*	-12	10
2	18	12	10	-19	18
3	-02	05	22	-01	08
4	-34	13	12	-16	06
5	-04	23	-04	-26	09
6	04	12	20	-16	86*
7	53*	-00	01	01	11
8	-08	-11	12	-04	-05
9	03	-22	-01	-07	62*
10	52*	15	07	-05	10
11	-10	03	75*	-14	-01
12	-29	-28	-03	-19	38*
13	-01	56*	-03	-16	-04
14	09	92*	03	-08	05
15	70*	22	-27	12	01
16	60*	-04	-24	-14	-18
17	33	-18	-21	-04	-30
18	61*	06	-02	10	-31
19	42*	-08	-03	-27	07
20	60*	12	-07	-14	-07
21	-26	25	70*	14	07
22	-02	-01	06	95*	-08
23	06	-05	09	03	-04
24	-35*	-09	46*	37*	-01
25	05	74*	04	10	-14
26	-09	-06	-20	67*	-13
27	23	-01	-11	-26	-02

TABLE 4 FIRM 1

EQUIMAX ROTATION

	FACTOR NUMBER				
ITEM NO.	1	2	3	4	5
1	-12	15	71*	04	13
2	-17	11	09	17	18
3	01	03	20	16	08
4	-13	10	10	-29	05
5	-23	21	-07	-17	06
6	-15	13	18	14	87*
7	-01	-01	-00	28	08
8	-04	-10	09	10	-05
9	-05	-23	-03	-14	60*
10	-06	16	04	75*	09
11	-12	02	75*	-24	-01
12	-17	-27	-04	-08	40*
13	-14	54*	-04	17	-03
14	-09	93*	02	03	03
15	08	22	-28	11	-05
16	-17	-04	-24	17	-22
17	-05	-18	-21	42*	-30
18	05	07	-01	42*	-32
19	-28	-10	-04	09	04
20	-14	08	-06	31	-09
21	16	-25	68*	17	11
22	93*	00	06	02	-09
23	02	-03	08	14	-05
24	36*	-07	47*	-29	01
25	12	72*	05	-08	-16
26	67*	-05	-18	-05	-14
27	-23	-02	-10	12	-02

TABLE 5 FIRM 2

PRINCIPAL COMPONENTS ANALYSIS

	FACTOR NUMBER										
ITEM NO.	1	2	3	4	5						
1	-45*	18	11	04	51*						
2	-69*	-19	23	32	-05						
3	-19	27	-12	-28	-28						
4	-33	22	-28	-21	-37						
5	66*	-03	21	-08	-17						
6	-23	48*	16	38*	-22						
7	34	36*	56*	33	-12						
8	47*	26	50*	-33	22						
9	-40*	14	31	09	20						
10	58*	41*	-25	27	29						
11	-60*	21	-50*	17	35						
12	71*	42*	-19	-28	03						
13	-41*	-12	-19	01	-18						
14	-36*	21	49*	-14	-06						
15	25	29	-21	38*	07						
16	-22	54*	-23	-19	-42*						
17	-05	07	-27	-50*	27						
18	-42*	01	-03	-01	-05						
19	11	29	-23	-21	42*						
20	-32	67*	02	-39*	-23						
21	-13	39*	-11	-35	13						
22	39*	44*	-22	31	14						
23	-27	49*	49*	-18	22						
24	-45*	23	-11	22	23						
25	08	79*	05	40*	-20						
26	14	-09	49*	-22	17						
27	-70*	10	22	-08	13						

TABLE 6 FIRM 2

VARIMAX ROTATION

ITEM NO.	FACTOR NUMBER				
	1	2	3	4	5
1	00	-07	14	63*	-08
2	-06	-72*	-15	38*	10
3	42*	20	-19	01	13
4	46*	05	-36*	-03	07
5	-04	11	29	-42*	04
6	21	-07	-06	18	65*
7	-05	05	45*	-08	68*
8	03	34	77*	-13	08
9	01	-14	05	56*	21
10	-12	54*	00	03	20
11	12	08	-50*	65*	-11
12	19	79*	17	-28	08
13	11	-23	-38*	09	-06
14	40*	55*	37*	24	01
15	-03	18	-09	01	22
16	75*	-06	-18	-11	10
17	29	20	05	12	-55*
18	07	-11	-03	02	03
19	10	50*	08	25	-18
20	88*	-04	09	17	05
21	47*	17	03	28	-16
22	09	15	02	-03	13
23	35*	02	51*	46*	21
24	14	-17	-23	59*	04
25	35*	18	-02	12	74*
26	-09	-06	57*	-01	-08
27	12	-14	-02	54*	14

TABLE 7 FIRM 2

QUARTIMAX ROTATION

	FACTOR NUMBER				
ITEM NO.	1	2	3	4	5
1	-06	00	14	67*	-07
2	-73*	-05	-13	41*	09
3	17	43*	-19	02	12
4	01	48*	-36*	-00	06
5	13	-05	30	-51*	04
6	-07	21	-06	20	65*
7	06	-05	46*	-11	68*
8	36*	03	76*	-13	08
9	-15	02	07	55*	21
10	60*	-13	-01	-01	22
11	08	12	-50*	68*	-11
12	81*	18	15	-33	09
13	-25	12	37*	11	-07
14	-53*	39*	40*	23	01
15	21	-04	-09	-01	23
16	-06	75*	-18	-08	10
17	21	28	05	12	-55*
18	-13	08	-05	12	03
19	52*	09	07	25	-18
20	-03	88*	11	17	05
21	19	46*	04	26	-16
22	23	08	01	-04	15
23	02	34	52*	45*	20
24	-16	13	-22	57*	04
25	21	35*	-02	11	75*
26	-06	-10	57*	-03	-08
27	-18	13	-02	59*	13

TABLE 8 FIRM 2

EQUIMAX ROTATION

ITEM NO.	FACTOR NUMBER					
	1	2	3	4	5	6
1	-06	19	-02	53*	-10	40*
2	11	-12	-06	30	-70*	22
3	13	-19	39*	-02	25	01
4	07	-35*	45*	-07	10	19
5	03	24	-02	-29	10	-66*
6	65*	-06	19	12	-07	21
7	69*	43*	-05	-06	03	-20
8	07	74*	02	-25	31	-02
9	22	08	-03	47*	-14	-06
10	17	-03	-12	08	45*	-18
11	-09	-43*	09	67*	07	43*
12	07	13	18	-20	77*	-32
13	-06	-36*	11	07	-19	13
14	02	37*	40*	18	-55*	-05
15	24	-08	-01	18	14	-04
16	10	-19	76*	-10	-06	18
17	-54*	08	29	16	20	08
18	04	01	07	-11	-07	77*
19	-17	11	08	28	48*	11
20	08	11	87*	21	-01	04
21	-16	04	45*	30	16	-11
22	11	-02	10	01	04	-05
23	25	56*	33	44*	04	14
24	06	-20	12	62*	-19	02
25	74*	-03	34	14	14	02
26	-07	57*	-09	-05	-05	-09
27	14	02	07	34	-11	41*

TABLE 9 FIRM 3

PRINCIPAL COMPONENTS ANALYSIS

	FACTOR NUMBER	
ITEM NO.	1	2
1	81*	15
2	-18	59
3	23	64*
4	-17	-13
5	61*	04
6	71*	30
7	71*	-03
8	30	-79*
9	65*	33
10	56	-77*
11	61*	-42
12	47	-44
13	43	-30
14	61*	20
15	85*	09
16	-26	85*
17	73*	48
18	60	31
19	68*	44
20	79*	22
21	54	15
22	13	35
23	33	-61
24	-44	-17
25	25	-10
26	-52	-07
27	-47	73*

TABLE 10 FIRM 3

VARIMAX ROTATION

ITEM NO.	FACTOR NUMBER		
	1	2	3
1	13	07	33
2	-51	10	08
3	-65*	14	13
4	16	-07	-11
5	15	-01	27
6	-08	05	02
7	27	12	60
8	85*	-14	13
9	-04	13	18
10	91*	08	13
11	48	-09	68*
12	49	13	11
13	25	03	27
14	-02	92*	30
15	19	10	24
16	-82*	-09	-09
17	-10	51	03
18	00	03	05
19	-16	53	04
20	12	27	36
21	-04	08	72*
22	-28	-21	68*
23	74*	09	-08
24	-08	-54‡	54
25	21	89*	-26
26	-06	-24	09
27	-89*	-21	12

‡ significant at the .05 level only

TABLE 11 FIRM 3

QUARTIMAX ROTATION

	FACTOR NUMBER										
ITEM NO.	1	2									
1	75*	15									
2	10	-55									
3	34	-59									
4	-11	10									
5	55	17									
6	75*	-04									
7	55	29									
8	00	86*									
9	72*	-04									
10	22	93*									
11	26	56									
12	18	55									
13	14	31									
14	47	01									
15	84*	24									
16	16	-86*									
17	89*	-12									
18	81*	03									
19	79*	-14									
20	79*	13									
21	42	03									
22	18	-29									
23	08	70*									
24	-53	-03									
25	11	19									
26	-49	-08									
27	-17	-88*									

TABLE 12 FIRM 3

EQUIMAX ROTATION

	FACTOR NUMBER			
ITEM NO.	1	2	3	4
1	07	27	12	31
2	-31	02	-29	07
3	-81*	17	16	09
4	37	04	-77*	-12
5	14	13	01	26
6	-20	31	37	01
7	27	12	04	60
8	74*	17	21	17
9	-05	31	08	16
10	79*	21	31	17
11	28	09	40	69*
12	24	04	82*	14
13	03	04	-00	25
14	-10	18	10	30
15	08	73*	05	23
16	-60	06	-68*	-14
17	-01	54	-27	01
18	-03	97*	00	04
19	-18	50 ‡	-06	03
20	09	44	17	36
21	-15	22	16	71*
22	-15	-10	-56	65*
23	79*	-20	-11	-06
24	-14	-13	15	55
25	17	-05	23	-24
26	-01	-29	27	12
27	-85*	01	-23	08

‡ significant at the .05 level only

TABLES 13 TO 21

OUTCOME OF THE ANALYSES OF THE WORKERS' PERSONAL HEARING PROTECTORS QUESTIONNAIRE

TABLE 13 FIRM 1

PRINCIPAL COMPONENTS

	FACTOR NUMBER										
ITEM NO.	1	2	3	4	5						
1	-64*	10	-13	01	-57*						
2	-68*	08	-04	-07	-53*						
3	-52*	05	11	01	-33						
4	-05	-68*	09	44*	-25						
5	57*	-17	31	-21	-49*						
6	36*	49*	-50*	-14	-18						
7	-69*	32	17	21	-07						
8	02	-62*	52*	35	00						
9	-54*	33	31	35	07						
10	-33	01	31	-28	-13						
11	-72*	36*	-13	00	16						
12	-12	-62*	26	39*	10						
13	69*	-39*	27	-24	-13						
14	40*	-19	-30	28	-26						
15	-62*	17	01	-18	27						
16	48*	21	-26	42*	02						
17	-68*	-41*	-12	-28	01						
18	-08	-46*	-44*	-05	50*						
19	-07	-56*	-26	-11	-09						
20	-58*	-49*	-05	-28	08						
21	-60*	01	24	-26	18						
22	10	-25	-65*	20	-09						
23	-26	-63*	-29	02	01						
24	48*	-12	-15	-62*	-05						
25	-60*	-40*	-31	-19	-00						
26	25	-10	48*	-39*	-01						
27	55*	25	-42*	-14	-06						
28	56*	-26	12	-42*	03						
29	48*	-15	-38*	28	04						
30	39*	12	26	13	00						
31	36*	23	28	03	19						
32	-39*	03	-60*	-11	-05						

TABLE 14 FIRM 1

VARIMAX ROTATION

	FACTOR NUMBER										
ITEM NO.	1	2	3	4	5	6	7				
1	-33	-14	-00	-17	-77*	-23	02				
2	-15	-20	-02	-16	-80*	-09	19				
3	-06	-20	09	-12	-59*	21	40*				
4	01	-25	71*	21	-19	-06	-29				
5	65*	32	09	07	-16	18	-40*				
6	07	31	-62*	38*	-03	-33	-10				
7	-50*	02	09	-11	-43*	-05	38				
8	12	02	87*	-04	09	23	-03				
9	-59*	18	15	-16	-15	17	26				
10	06	-13	05	-20	-15	-01	08				
11	-40*	-12	-10	-05	-25	-12	80*				
12	-03	-03	87*	01	08	-20	03				
13	78*	11	18	10	17	15	-31				
14	18	07	11	66*	07	01	-11				
15	-12	-20	-02	-15	-11	02	88*				
16	-02	24	-11	76*	18	-01	-04				
17	-15	-85*	10	-20	-14	-05	11				
18	02	-22	19	-19	46*	-62*	10				
19	30	-13	26	-32	-12	-31	-05				
20	-02	-82*	17	-14	-02	-02	14				
21	-15	-18	-00	-65*	-12	01	21				
22	03	-14	-02	34	-04	-60*	-19				
23	13	-51*	38*	09	-06	-38*	09				
24	60*	-12	-28	04	13	-11	-08				
25	-12	-87*	-00	-11	-18	-14	06				
26	42*	07	15	-11	04	08	-04				
27	27	25	-40*	32	09	-06	09				
28	86*	21	05	05	23	-02	09				
29	15	13	04	24	14	-20	-17				
30	-04	21	12	06	15	25	-12				
31	13	29	-05	-06	10	06	-06				
32	-15	-07	-17	-08	-23	-82*	15				

TABLE 15 FIRM 1

PROMAX ROTATION

	FACTOR NUMBER										
ITEM NO.	1	2	3	4	5	6	7	8	9	10	11
1	-44*	-22	02	-27	-83*	-21	22	22	15	-19	15
2	-36*	-28	05	-28	-87*	-09	35	01	41*	-05	21
3	-24	-23	13	-27	-63*	22	48*	01	20	-26	-19
4	08	-36*	74*	13	-21	-05	-33	-12	16	36	-11
5	67*	33	05	18	01	23	-56*	04	-21	-02	06
6	12	38*	-70*	51*	08	-35	-16	08	-28	06	07
7	-68*	-03	11	-22	-57*	02	53*	-27	49*	-23	42*
8	16	-08	86*	-15	06	31	-12	09	10	-04	-11
9	-69*	15	16	-25	-29	28	42*	-04	46*	-45*	19
10	-09	-13	09	-32	-21	11	19	06	16	-81*	17
11	-59*	-15	-10	-24	-39*	-14	91*	05	26	-19	21
12	02	-18	84*	-10	02	-11	-03	-02	10	03	-02
13	83*	13	16	21	33	19	-54*	-17	-25	10	-12
14	30	09	04	62*	16	-05	-27	39*	-22	14	-37
15	-33	-23	00	-36*	-24	-02	92*	07	26	-18	14
16	08	31	-19	83*	26	-02	-22	-33	-06	29	-08
17	-25	-87*	23	-45*	-29	-16	30	31	18	-08	08
18	10	-34	21	-22	39*	-65*	10	24	-01	26	-31
19	32	-28	31	-32	-11	-39*	-08	34	05	64*	-26
20	-12	-84*	30	-40*	-17	-12	27	24	26	-10	06
21	-32	-24	11	-71*	-27	03	38*	-11	51*	-06	33
22	11	-21	-01	37*	-01	-61*	-22	-04	06	33	-44*
23	11	-62*	44*	-06	-11	-43*	08	08	14	27	-22
24	66*	-06	-32	11	29	-21	-22	16	-72*	14	08
25	-21	-89*	14	-30	-31	-26	23	09	27	11	-13
26	38*	09	11	-07	11	13	-16	-28	-28	-08	59*
27	39*	31	-51*	43*	26	-16	-08	27	-70*	27	-30
28	83*	20	01	10	37*	-00	-16	05	-17	08	-06
29	31	10	-02	38*	27	-20	-30	-11	-33	27	-73*
30	10	26	01	18	17	26	-21	-18	-71*	-03	-01
31	14	32	-10	14	19	17	-15	-78*	-15	-02	06
32	-22	-19	-16	-11	-29	-81*	25	15	15	09	04

TABLE 16 FIRM 2

PRINCIPAL COMPONENTS ANALYSIS

	FACTOR NUMBER										
ITEM NO.	1	2	3	4	5	6	7				
1	-46*	15	04	23	20	-24	08				
2	53*	-24	-03	46*	40*	-17	20				
3	-26	-36*	17	-42*	43*	26	-39*				
4	31	-05	72*	07	-11	-24	-01				
5	25	-65*	13	08	-03	17	12				
6	22	-63*	11	23	41*	06	-16				
7	-73*	-28	-12	08	-20	25	04				
8	-20	-36*	35	22	-38*	-27	-32				
9	-61*	-18	-13	-11	27	-48*	12				
10	-38*	21	48*	06	-02	-27	01				
11	05	-52*	-39*	-24	28	33	16				
12	04	-37*	-39*	-12	-16	-40*	-20				
13	-17	38*	56*	14	08	28	38*				
14	-11	38*	66*	25	26	27	-09				
15	-63*	-12	15	-24	11	-27	11				
16	-50*	-18	-22	26	35	-38*	30				
17	-25	-46*	52*	03	03	-01	23				
18	15	-14	12	66*	14	-01	20				
19	-57*	20	-24	47*	-02	09	12				
20	-68*	-32	13	15	-18	11	-26				
21	50*	-25	-08	57*	-16	10	-26				
22	-53*	-26	-05	-15	02	-00	33				
23	-49*	-16	33	-29	25	32	-08				
24	30	21	06	-11	64*	-43*	-16				
25	-10	51*	36*	29	41*	05	-27				
26	-69*	-23	01	19	-04	20	-22				
27	-06	-19	-39*	56*	12	31	19				
28	21	-55*	-12	-06	42*	03	-01				
29	33	-45*	43*	-29	27	04	01				
30	-39*	-02	-31	42*	15	-11	-52*				
31	08	-54*	35	-01	-39*	-18	10				
32	12	-55*	39*	23	-28	-13	02				

TABLE 17 FIRM 2

VARIMAX ROTATION

	FACTOR NUMBER										
ITEM NO.	1	2	3	4	5	6	7	8			
1	-26	17	03	14	02	-23	06	05			
2	46*	-08	-00	75*	04	01	01	-03			
3	-14	05	04	-24	81*	-05	-19	-11			
4	35*	-63*	33	-01	06	15	09	07			
5	-09	-45*	-20	36*	34	14	21	06			
6	07	-21	-09	55*	60*	-01	-10	-06			
7	-82*	-05	-10	-05	05	-22	-03	-05			
8	-28	-61*	-09	-01	10	-09	-22	09			
9	-11	00	-13	-07	07	-86*	-15	-12			
10	03	-26	41*	-27	-19	-07	-20	-28			
11	-06	10	-31	18	33	-05	03	-13			
12	06	-02	-72*	-01	04	02	-16	-30			
13	-15	02	74*	01	-07	-05	43*	-04			
14	01	-02	88*	-00	09	13	-12	-05			
15	-18	-20	13	-29	08	-80*	-08	03			
16	-16	15	-12	35	-05	-64*	-04	-31			
17	-16	-48*	24	06	22	-20	12	-54*			
18	-04	-16	15	70*	-08	08	05	07			
19	-57*	26	16	24	-30	-39*	-10	16			
20	-59*	-28	10	-15	06	-11	-48*	-33			
21	05	-24	-15	56*	-07	50*	-27	19			
22	-31	02	-07	-13	-03	-23	09	-73*			
23	-43*	05	24	-22	61*	-20	18	-04			
24	70*	21	06	09	28	-20	-12	19			
25	16	26	71*	03	03	01	-35	-02			
26	-73*	01	03	01	21	-15	-23	-10			
27	-28	16	02	61*	-21	-01	-19	-11			
28	25	01	-19	30	40*	02	-14	-57*			
29	25	-34	01	07	65*	02	31	04			
30	-25	16	-03	18	-03	-24	-77*	08			
31	-02	-82*	-12	-01	-01	-07	03	-00			
32	-08	-69*	-08	24	10	12	04	-17			

TABLE 18 FIRM 2

PROMAX ROTATION

	FACTOR NUMBER										
ITEM NO.	1	2	3	4	5	6	7	8			
1	-28	20	11	05	-01	-35	-04	-01			
2	42*	-04	-15	74*	14	13	02	-02			
3	-07	-07	04	-24	73*	-10	-21	-24			
4	38*	-64*	32	-04	15	25	12	05			
5	-06	-46*	-28	39*	40*	16	22	01			
6	08	-20	-24	60*	68*	03	-07	-16			
7	-83*	-02	-03	-09	-00	-38*	-09	-15			
8	-27	-54*	-07	03	19	-07	-18	-04			
9	-24	11	-09	-07	10	-85*	-19	-26			
10	05	-32	53*	43*	-19	-06	-30	-33			
11	-06	03	-36*	17	28	-04	01	-15			
12	05	-01	-70*	08	10	06	-21	-31			
13	-16	05	73*	-04	-07	-15	43*	00			
14	07	-08	86*	-11	05	10	-12	-07			
15	-30	-13	19	-32	09	-78*	-08	-12			
16	-28	26	-13	-32	01	-67*	-13	-39*			
17	-18	-47*	21	06	32	-19	08	-61*			
18	-04	-10	07	63*	-02	08	03	05			
19	-65*	40*	17	21	-33	-51*	-10	10			
20	-56*	-31	17	-23	03	-17	-54*	-48*			
21	13	-24	-24	56*	-02	57*	-23	19			
22	-35*	-00	-01	-17	-01	-30	-05	-74*			
23	-41*	03	25	-20	55*	-35	17	-14			
24	68*	19	03	07	29	-08	-12	15			
25	20	23	69*	-04	-01	00	-34	-05			
26	-71*	03	07	-02	17	-30	-27	-23			
27	-31	20	-08	55*	-22	-03	-21	-12			
28	25	-05	-30	34	46*	10	-18	-59*			
29	28	-38*	-08	14	72*	07	35	-01			
30	-26	21	-04	14	-06	23	-76*	-07			
31	-03	-80*	-12	00	10	04	07	-07			
32	-06	-67*	-12	26	23	17	05	-23			

TABLE 19 FIRM 3

PRINCIPAL COMPONENTS ANALYSIS

	FACTOR NUMBER										
ITEM NO.	1	2									
1	-69*	56									
2	-54	-31									
3	-80*	-40									
4	-47	-43									
5	61*	54									
6	44	41									
7	-73*	56									
8	-38	-47									
9	-74*	51									
10	-03	02									
11	-79*	42									
12	-58	-45									
13	49	-48									
14	-47	-43									
15	-64*	-16									
16	60	35									
17	16	28									
18	-15	64*									
19	-23	-04									
20	09	-16									
21	-70*	60									
22	03	46									
23	-51	27									
24	-22	-22									
25	17	33									
26	36	38									
27	-14	-23									
28	-16	-15									
29	11	80*									
30	-26	-26									
31	-54	-29									
32	-38	-63*									

TABLE 20 FIRM 3

VARIMAX ROTATION

	FACTOR NUMBER										
ITEM NO.	1	2	3	4	5						
1	-85*	11	-35	03	-16						
2	-14	01	-90*	07	10						
3	-33	-13	-60*	-13	38						
4	-07	-26	-37	30	06						
5	82*	16	01	42	08						
6	09	56	-19	04	-36						
7	-90*	-20	06	12	-11						
8	02	-86*	-02	-19	17						
9	-92*	03	08	-01	23						
10	03	71*	-50	-05	06						
11	-89*	-15	-20	19	06						
12	-13	-86*	-28	03	09						
13	76*	-17	-19	11	-17						
14	-03	-69*	-40	-18	-05						
15	-48	-15	-21	-03	76*						
16	15	15	94*	03	00						
17	-02	-01	-07	86*	-34						
18	-46	21	-12	17	-43						
19	-06	05	-17	-01	-10						
20	12	18	-40	75*	30						
21	-93*	02	-05	03	-11						
22	-14	05	02	23	-89*						
23	-43	-05	-16	-16	-37						
24	03	-37	04	-46	-09						
25	-09	03	30	90*	-09						
26	-03	19	07	06	-21						
27	16	-00	-41	-22	-30						
28	05	22	04	-24	-21						
29	-40	20	60	-07	-61 ǂ						
30	02	00	-14	03	-02						
31	-19	-26	-21	-05	06						
32	14	-43	-32	12	53						

ǂ significant at .05 level only

TABLE 21 FIRM 3

PROMAX ROTATION

	FACTOR NUMBER									
ITEM NO.	1	2	3	4	5					
1	-87*	06	-40	-01	-22					
2	-16	-08	-93*	12	19					
3	-34	-26	-67*	-09	47					
4	-07	-26	-43	34	26					
5	83*	23	01	44	15					
6	09	63*	-15	01	-51					
7	-92*	-25	-02	06	-13					
8	01	-90*	-03	-16	34					
9	-92*	-05	00	-04	14					
10	02	61	-48	-03	00					
11	-88*	-19	-26	20	08					
12	-14	-89*	-32	07	30					
13	74*	-17	-17	09	-10					
14	-06	-71*	-44	-18	09					
15	-44	-27	-27	05	73*					
16	17	23	95*	-04	-16					
17	-02	09	-10	84*	-29					
18	-48	23	-17	07	-57					
19	-10	03	-22	-06	-10					
20	16	25	-44	82*	33					
21	-93*	-00	-12	-00	-16					
22	-19	11	-00	10	-88*					
23	-49	-17	-18	-23	-35					
24	-01	-43	-12	-55	-12					
25	-08	13	20	83*	-14					
26	-00	34	11	07	-30					
27	11	-05	-45	-29	-29					
28	01	19	01	-29	-16					
29	-42	26	59	-21	-75*					
30	-01	-03	-24	-04	-02					
31	-20	-30	-22	01	26					
32	13	-53	-38	17	64					

TABLES 22 TO 33

OUTCOME OF THE ANALYSES OF THE
INDUSTRIAL MEDICAL OFFICERS' QUESTIONNAIRE

TABLE 22 Medical officers performing audiometry (N = 126). Principal components analysis of attitude questionnaire.

	FACTOR NUMBER				
ITEM NO.	1	2	3	4	5
1	-51*	-02	12	14	23
2	-81*	21	14	-14	12
3	47*	-31*	11	-21	09
4	-72*	16	14	-05	-08
5	57*	05	-09	18	-06
6	31*	22	-14	-16	-04
7	54*	21	03	35*	-09
8	-27*	02	-28*	-14	-07
9	47*	25*	-18	33*	-20
10	52*	-18	-31*	-09	-17
11	-35*	-40*	-30*	-03	36*
12	-64*	41*	-15	07	15
13	-66*	20	02	17	-01
14	-50*	-29*	-07	19	-22
15	17	-13	39*	-32*	-25
16	-60*	13	-12	-07	-16
17	62*	03	-37*	-17	27*
18	-33*	-03	-41*	-08	-18
19	-14	-23	-34*	01	-12
20	36*	-23	-02	-15	-14
21	-46*	-62*	-02	27*	03
22	-57*	-28*	-01	15	01
23	38*	31*	-22	-06	13
24	-68*	29*	-22	-01	-09
25	19	21	11	-10	10
26	-54*	02	-04	-22	-25*
27	-48*	-04	-09	-34*	02

TABLE 23 Medical officers performing audiometry (N = 126).
Varimax rotation of attitude questionnaire analysis.

	FACTOR NUMBER										
ITEM NO.	1	2	3								
1	42*	-22	21								
2	67*	-11	45*								
3	-26*	17	-04								
4	68*	-17	24*								
5	-27*	22	-48*								
6	-02	41*	-18								
7	-16	19	-62*								
8	18	-03	15								
9	-16	21	-63*								
10	-43*	15	-23								
11	06	-07	35*								
12	71*	-05	16								
13	66*	-22	08								
14	25*	-55*	07								
15	-10	-01	09								
16	61*	-05	12								
17	-52*	61*	-10								
18	18	03	07								
19	-09	-12	05								
20	-34*	-04	-04								
21	08	-40	12								
22	32*	-30*	17								
23	-09	50*	-22								
24	56*	-10	19								
25	-01	22	-03								
26	42*	-09	25*								
27	30*	01	44*								

TABLE 24 Medical officers performing audiometry (N = 126).
Quartimax rotation of attitude questionnaire analysis.

	FACTOR NUMBER		
ITEM NO.	1	2	3
1	49*	20	-17
2	84*	02	-05
3	-46*	-07	-12
4	76*	09	-01
5	-49*	-18	-04
6	-18	-41*	07
7	-41*	-19	-20
8	23	-02	32*
9	-36*	-21	04
10	-56*	-09	30*
11	19	27*	23
12	72*	-13	04
13	69*	11	-01
14	34*	51*	20
15	-14	-02	-15
16	64*	01	24
17	-58*	-42*	17
18	27*	04	50*
19	00	20	40*
20	-41*	03	08
21	25*	70*	14
22	46*	43*	11
23	-24*	-48*	03
24	69*	-02	27*
25	09	-28*	-18
26	52*	06	27*
27	44*	-01	23

TABLE 25 Medical officers performing audiometry (N = 126).
Equimax rotation of attitude questionnaire analysis.

	FACTOR NUMBER										
ITEM NO.	1	2	3								
1	38*	29*	19								
2	34*	14	45*								
3	-15	08	-04								
4	27*	15	24*								
5	-10	-11	-48*								
6	-04	-20	-16								
7	-07	-14	-61*								
8	22	-04	16								
9	-09	-19	-62*								
10	-18	-14	-22								
11	30*	52*	31*								
12	70*	-04	16								
13	46*	15	07								
14	22	24*	06								
15	-44*	-12	12								
16	28*	14	12								
17	-20	-08	-11								
18	08	12	07								
19	-01	14	04								
20	-18	-14	-03								
21	-08	80*	07								
22	13	50*	14								
23	05	-21	-21								
24	39*	-02	20								
25	-00	-19	-01								
26	01	08	26*								
27	11	10	44*								

TABLE 26 Medical officers not performing audiometry (N = 108).
Principal components analysis of attitude questionnaire.

	FACTOR NUMBER			
ITEM NO.	1	2	3	4
1	-60*	17	13	03
2	-74*	-19	14	-07
3	41*	21	00	-08
4	-70*	-01	05	-13
5	66*	-06	-49*	-02
6	22	-38*	-22	-04
7	63*	-04	-20	09
8	-32*	-11	09	52*
9	25*	00	-22	19
10	65*	12	-15	22
11	-50*	19	-29*	-29*
12	-72*	-11	-32*	-03
13	-71*	-21	-20	06
14	-40*	47*	-26*	-08
15	28*	02	09	-43*
16	-66*	-05	-19	-08
17	65*	01	-11	08
18	-55*	-17	-32*	12
19	04	04	17	30*
20	38*	30*	00	-32*
21	-38*	37*	-21	15
22	-57*	45*	-15	11
23	49*	-21	-40*	-08
24	-72*	-19	-25	00
25	19	-28*	-03	-21
26	-45*	-19	19	07
27	-33*	-15	11	-37*

TABLE 27 Medical officers not performing audiometry (N = 108).
Varimax rotation of attitude questionnaire analysis.

	FACTOR NUMBER			
ITEM NO.	1	2	3	4
1	24	43*	23	25
2	21	48*	51*	15
3	-06	-17	-46*	00
4	36*	38*	42*	11
5	05	-69*	-27*	-23
6	-08	-06	-04	-06
7	-16	-56*	-29*	-18
8	00	11	30*	08
9	-16	-47*	05	06
10	04	-43*	-54*	-21
11	55*	21	11	36*
12	21	11	71*	40*
13	36*	27*	62*	11
14	63*	08	00	21
15	03	02	-33*	-21
16	50*	29*	45*	08
17	-20	-45*	-38*	-20
18	49*	13	41*	15
19	01	-01	-12	-02
20	10	-03	-61*	02
21	18	05	11	57*
22	17	20	14	80*
23	12	-55*	-15	-29*
24	31*	19	65*	24
25	-06	-10	-06	-11
26	10	37*	27*	04
27	16	49*	13	-09

TABLE 28 Medical officers not performing audiometry (N = 108). Quartimax rotation of attitude questionnaire analysis.

	FACTOR NUMBER			
ITEM NO.	1	2	3	4
1	55*	18	07	11
2	78*	-00	-09	16
3	-45*	12	06	04
4	70*	-02	13	05
5	-63*	-14	28*	-17
6	-17	-03	-09	-05
7	-60*	-09	04	04
8	31*	01	-06	47*
9	-23	04	-05	-04
10	-68*	-04	27*	30*
11	46*	32*	36*	-05
12	74*	20	-01	-30*
13	73*	-04	16	-03
14	30*	22	60*	-03
15	-25*	-12	05	-14
16	66*	-02	31*	-05
17	-64*	-09	02	-00
18	56*	04	31*	22
19	-05	00	01	55*
20	-44*	18	19	-03
21	28*	53*	12	-00
22	44*	74*	02	01
23	-42*	23	26*	-03
24	74*	06	08	-09
25	-11	-11	-12	09
26	47*	-04	-10	32*
27	34*	-12	01	-28*

TABLE 29 Medical officers not performing audiometry (N = 108). Equimax rotation of attitude questionnaire analysis.

	FACTOR NUMBER			
ITEM NO.	1	2	3	4
1	22	29*	-32*	08
2	27	16	-26*	28*
3	-16	01	11	-30*
4	38*	12	-20	26*
5	06	-26*	50*	-13
6	01	-05	-08	00
7	-17	-23	48*	-23
8	09	10	-07	-17
9	-13	-00	48*	05
10	-02	-19	24	-63*
11	51*	39*	-12	12
12	32*	37*	02	66*
13	48*	14	-22	37*
14	55*	27*	-09	-07
15	-06	-21	-02	-06
16	56*	13	-25*	27*
17	-23	-22	32*	-27*
18	59*	18	-10	06
19	-01	-02	08	-44*
20	-05	04	-03	-34*
21	16	59*	00	05
22	13	82*	-08	11
23	16	-33*	46*	-12
24	42*	24	-08	46*
25	-04	-15	19	-02
26	15	06	-24	-00
27	16	-04	-52*	29*

TABLE 30 Medical officers performing audiometry in some companies, but not in others (N = 34).

Principal components analysis of attitude questionnaire.

	FACTOR NUMBER										
ITEM NO.	1	2	3								
1	-50*	-11	50*								
2	-77*	30	-00								
3	29	-38	24								
4	-85*	-02	03								
5	61*	-16	09								
6	39	15	-44								
7	74*	-21	22								
8	-64*	16	40								
9	36	-29	-34								
10	80*	-15	-01								
11	-43*	-47*	-40								
12	-79*	-19	07								
13	-62*	-07	15								
14	-57*	04	27								
15	49*	-01	07								
16	-69*	-29	-08								
17	66*	-57*	01								
18	-72*	-49*	13								
19	14	-52*	47*								
20	29	-13	39								
21	-70*	-13	-15								
22	-75*	-24	-12								
23	46*	-23	-08								
24	-74*	-14	-17								
25	36	-31	-22								
26	-53*	-18	-50*								
27	-67*	-16	-05								

TABLE 31 Medical officers performing audiometry in some companies, but not in others (N = 34).

Varimax rotation of attitude questionnaire analysis.

	FACTOR NUMBER			
ITEM NO.	1	2	3	4
1	25	81*	02	08
2	25	12	-27	78*
3	-09	-08	55*	03
4	55*	07	-38	57*
5	-36	01	64*	-26
6	-18	-44*	05	-09
7	-31	-18	26	-30
8	08	31	-08	81*
9	11	-59*	23	-27
10	-38	-31	28	-49*
11	74*	-02	00	-16
12	61*	28	-15	45
13	41	47*	-15	21
14	22	13	08	34
15	-34	-24	33	-24
16	72*	11	-27	21
17	-06	-32	69*	-43
18	68*	37	21	45
19	05	09	14	-08
20	-25	-15	08	-03
21	62*	25	-10	20
22	64*	27	00	42
23	-10	-49*	14	-18
24	66*	07	-26	30
25	-05	-19	46*	00
26	64*	-06	-25	-01
27	47*	14	03	50*

TABLE 32 Medical officers performing audiometry in some companies, but not in others (N = 34).

Quartimax rotation of attitude questionnaire analysis.

	FACTOR NUMBER				
ITEM NO.	1	2	3	4	5
1	44*	10	-71*	01	08
2	74*	-23	09	-46*	-10
3	-21	23	05	-05	53*
4	86*	14	16	-13	-21
5	-58*	-17	-15	01	53*
6	-34	-41 ‡	37 ‡	-02	02
7	-62*	08	08	-06	16
8	62*	09	-11	-60*	07
9	-27	-03	52	32	17
10	-75*	12	13	16	14
11	49*	00	11	60*	09
12	82*	04	-07	-02	02
13	59*	02	-33	04	-05
14	50*	01	-04	-10	09
15	-50*	02	11	02	19
16	74*	14	08	23	-13
17	-55*	16	19	33	57*
18	80*	14	-15	04	41
19	-07	85*	-07	07	16
20	-28	52*	11	-13	02
21	70*	-21	-10	20	01
22	79*	-12	-07	05	19
23	-37	22	42 ‡	08	08
24	76*	-05	12	14	-11
25	-25	-06	16	01	50*
26	55*	-10	16	43	-14
27	69*	01	04	-08	19

‡ significant at .05 level only

TABLE 33 Medical officers performing audiometry in some companies, but not in others. (N = 34).

Equimax rotation of attitude questionnaire analysis.

	FACTOR NUMBER										
ITEM NO.	1	2	3	4	5	6					
1	-01	-01	11	27	83*	09					
2	-35	-30	67*	29	07	-02					
3	11	52*	10	-05	-05	-04					
4	-25	-45*	56*	42 ‡	09	31					
5	22	67*	-21	-27	01	-23					
6	24	08	-05	-30	-44	-10					
7	96*	19	-06	-24	-04	-26					
8	-33	-14	70*	25	27	-19					
9	32	23	-14	08	-52*	25					
10	40	30	-41	-29	-27	-18					
11	-15	-03	01	07	04	77*					
12	-13	-23	53*	30	33	39					
13	-17	-19	24	21	49*	25					
14	-26	09	20	89*	09	08					
15	13	38	-29	11	-26	-22					
16	-00	-36	35	28	19	57*					
17	43*	67*	-23	-11	-24	13					
18	-21	10	61*	07	43	50*					
19	03	06	03	-16	15	09					
20	13	06	-06	14	-14	-21					
21	-14	-13	27	33	28	48*					
22	-27	-07	52*	07	03	47					
23	35	11	-07	-11	-43	00					
24	-13	-31	37	33	11	50*					
25	-03	44*	13	-65*	-18	05					
26	-35	-26	05	02	-05	64*					
27	-47*	-02	50*	12	12	32					

‡ significant at .05 level only

APPENDIX 3: QUESTIONNAIRE ITEMS CONTRIBUTING TO SIGNIFICANT FACTORS EXTRACTED

APPENDIX 3

Descriptions of the significant factors extracted from the factor analyses and subsequent rotations used in the present research. Each factor is described in terms of the statements loading significantly upon it ranked in descending order of magnitude of factor loading. The number accompanying each statement on the left of it corresponds to the number of that statement upon its respective questionnaire.

The factors are recorded in order of extraction without the names given to them. The purpose of not including the factor names is to permit the reader to make independent assessments of what each factor represents without interference from the author's own suggestions. These are, of course, included in the text.

The first block of factors consists of those extracted from the analyses of the Workers' Audiometry Questionnaire. The second block consists of those extracted from the Workers' Personal Hearing Protectors Questionnaire. In each case the analyses of the data from the three firms used are presented in order, that is, first of all that for Firm 1, then that for Firm 2, and then that for Firm 3. The third and final block consists of those factors extracted from the Industrial Medical Officers' Questionnaire. The order of presentation for the three groups of respondents is:

(i) medical officers performing audiometry;
(ii) medical officers not performing audiometry;
(iii) medical officers performing audiometry in some companies, but not in others.

WORKERS' AUDIOMETRY QUESTIONNAIRE

FIRM 1

52 RESPONDENTS

Firm 1 Principal Components Analysis

Factor 1

ITEM	LOADING
21. Hearing tests done at work are useful to both managements and employees.	0.75
16. Hearing tests at work should be compulsory.	0.65
24. Hearing tests done at work are pointless.	-0.63
21. Hearing tests are best left to the National Health Service.	-0.62
15. The provisions of hearing tests is a sign of an employer's concern for the hearing of his employees.	0.61
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.	0.60
17. Hearing tests at work are necessary.	0.49
27. Work is just as good a place as any to perform hearing tests.	0.49
10. The younger you are, the more useful it is to have your hearing tested.	0.47

Firm 1 Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
4. Hearing tests done at work are more valuable to managements than employees.	-0.47
11. Hearing tests should be done by your own doctor and not at work.	-0.39
7. The older you are, the more useful it is to have your hearing tested.	0.38
1. Conducting hearing tests is the job of the National Health Service, not the employer.	-0.36
19. It's every employee's right to have his hearing tested.	0.35

Firm 1 Principal Components Analysis

Factor 2

ITEM	LOADING
22. There's no point in testing a woman's hearing at work.	0.68
26. Testing hearing is not a medical problem.	0.57
5. Having your hearing tested at work makes you worry about your hearing.	-0.55
2. Hearing tests should not be used to disqualify a person from employment.	-0.52
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	-0.48
11. Hearing tests should be done by your own doctor and not at work.	-0.43
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	-0.40
4. Hearing tests done at work are more valuable to managements than employees.	-0.38
27. It's every employee's right to have his hearing tested.	-0.38

Firm 1 Principal Components Analysis

Factor 2 cont'd

ITEM	LOADING
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.	0.36
13. Hearing tests at work encourage people to have medical checkups they might otherwise not have had.	-0.36

Firm 1 Principal Components Analysis

Factor 3

ITEM	LOADING
14. Having your hearing tested at work makes you think about your hearing.	-0.80
25. Having your hearing tested at work makes you more aware of your hearing.	-0.68
13. Hearing tests at work encourage people to have medical checkups they might otherwise not have had.	-0.49
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.41
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	0.37

Firm 1 Principal Components Analysis

Factor 4

ITEM	LOADING
21. Hearing tests are best left to the National Health Service.	0.54
10. The younger you are, the more useful it is to have your hearing tested.	0.52
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.45
11. Hearing tests should be done by your own doctor and not at work.	0.37

Firm 1 Principal Components Analysis

Factor 5

ITEM	LOADING
23. People should not be paid for time spent having their hearing tested at work.	-0.44
5. Having your hearing tested at work make you worry about your hearing.	-0.51
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	0.64

Firm 1 Varimax Rotation

Factor 1

ITEM	LOADING
15. The provision of hearing tests is a sign of an employer's concern for the hearing of his employees.	0.71
16. Hearing tests at work should be compulsory	0.56
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.	0.54
20. Hearing tests done at work are useful to both managements and employees.	0.52
7. The older you are, the more useful it is to have your hearing tested.	0.52
10. The younger you are, the more useful it is to have your hearing tested.	0.43
19. It's every employee's right to have his hearing tested.	0.41

Firm 1 Varimax Rotation

Factor 2

ITEM	LOADING
14. Having your hearing tested at work makes you think about your hearing.	0.92
25. Having your hearing tested at work makes you more aware of your hearing.	0.74
13. Hearing tests at work encourage people to have medical checkups they might otherwise not have had.	0.55

Firm 1 Varimax Rotation

Factor 3

ITEM	LOADING
11. Hearing tests should be done by your own doctor and not at work.	0.75
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.72
21. Hearing tests are best left to the National Health Service.	0.70
24. Hearing tests done at work are pointless.	0.47

Firm 1 Varimax Rotation

Factor 4

ITEM	LOADING
22. There's no point in testing a woman's hearing at work.	-0.94
26. Testing hearing is not a medical problem.	-0.67
24. Hearing tests done at work are pointless	-0.37

Firm 1 Varimax Rotation

Factor 5

ITEM	LOADING
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	0.86
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	0.61
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.40

Firm 1 Quartimax Rotation

Factor 1

ITEM	LOADING
15. The provision of hearing tests is a sign of an employer's concern for the hearing of his employees.	0.70
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.	0.61
20. Hearing tests done at work are useful to both managements and employees.	0.60
16. Hearing tests at work should be compulsory.	0.60
7. The older you are, the more useful it is to have your hearing tested.	0.53
10. The younger you are, the more useful it is to have your hearing tested.	0.52
19. It's every employee's right to have his hearing tested.	0.42
24. Hearing tests done at work are pointless.	-0.35

Firm 1 Quartimax Rotation

Factor 2

ITEM	LOADING
14. Having your hearing tested at work makes you think about your hearing.	0.92
25. Having your hearing tested at work makes you more aware of your hearing.	0.74
13. Hearing tests at work encourage people to have medical checkups they might otherwise not have had.	0.56

Firm 1 Quartimax Rotation

Factor 3

ITEM	LOADING
11. Hearing tests should be done by your own doctor and not at work.	0.75
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.72
21. Hearing tests are best left to the National Health Service.	0.70
24. Hearing tests done at work are pointless.	0.46

Firm 1 Quartimax Rotation

Factor 4

ITEM	LOADING
22. There's no point in testing a woman's hearing at work.	0.95
26. Testing hearing is not a medical problem.	0.67
24. Hearing tests done at work are pointless.	0.37

Firm 1 Quartimax Rotation

Factor 5

ITEM	LOADING
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	0.86
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	0.62
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.38

Firm 1 Equimax Rotation

Factor 1

ITEM	LOADING
22. There's no point in testing a woman's hearing at work.	0.93
26. Testing hearing is not a medical problem.	0.67
24. Hearing tests done at work are pointless.	0.36

Firm 1 Equimax Rotation

Factor 2

ITEM	LOADING
14. Having your hearing tested at work makes you think about your hearing.	0.93
25. Having your hearing tested at work makes you more aware of your hearing.	0.72
13. Hearing tests at work encourage people to have medical checkups they might otherwise not have had.	0.54

Firm 1 Equimax Rotation

Factor 3

ITEM	LOADING
11. Hearing tests should be done by your own doctor and not at work.	0.75
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.71
21. Hearing tests are best left to the National Health Service.	0.68
24. Hearing tests done at work are pointless.	0.47

Firm 1 Equimax Rotation

Factor 4

ITEM	LOADING
10. The younger you are, the more useful it is to have your hearing tested.	0.75
17. Hearing tests at work are necessary.	0.48
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.	0.48

Firm 1 Equimax Rotation

Factor 5

ITEM	LOADING
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	0.87
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	0.60
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.40

WORKERS' AUDIOMETRY QUESTIONNAIRE

FIRM 2

51 RESPONDENTS

Firm 2 Principal Components Analysis

Factor 1

ITEM	LOADING
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.71
27. Work is just as good a place as any to perform hearing tests.	-0.70
2. Hearing tests should not be used to disqualify a person from employment.	-0.69
5. Having your hearing tests at work makes you worry about your hearing.	0.66
11. Hearing tests should be done by your own doctor and not at work.	-0.60
10. The younger you are, the more useful it is to have your hearing tested.	0.58
8. Hearing tests done at work are useful for some purposes but not for others.	0.47
1. Conducting hearing tests is the job of the National Health Service, not the employer.	-0.45
24. Hearing tests done at work are pointless.	-0.45

Firm 2

Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.	-0.42
13. Hearing tests at work encourage people to have medical checkups they might otherwise not have had.	-0.41
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	-0.40
22. There's no point in testing a woman's hearing at work.	0.39
14. Having your hearing tested at work makes you think about your hearing.	-0.36

Firm 2 Principal Components Analysis

Factor 2

ITEM	LOADING
25. Having your hearing tested at work makes you more aware of your hearing.	0.79
20. Hearing tests done at work are useful to both managements and employees.	0.67
16. Hearing tests at work should be compulsory.	0.54
23. People should not be paid for time spent having their hearing tested at work.	0.49
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	0.48
22. There's no point in testing a woman's hearing at work.	0.44
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.42
10. The younger you are, the more useful it is to have your hearing tested.	0.41
21. Hearing tests are best left to the National Health Service.	

Firm 2 Principal Components Analysis

Factor 2 cont'd

ITEM	LOADING
7. The older you are, the more useful it is to have your hearing tested.	0.36

Firm 2 Principal Components Analysis

Factor 3

ITEM	LOADING
7. The older you are, the more useful it is to have your hearing tested.	0.56
8. Hearing tests done at work are useful for some purposes but not for others.	0.50
11. Hearing tests should be done by your own doctor and not at work.	-0.50
26. Testing hearing is not a medical problem.	0.49
14. Having your hearing tested at work makes you think about your hearing.	0.49
23. People should not be paid for time spent having their hearing tested at work.	0.49

Firm 2 Principal Components Analysis

Factor 4

ITEM	LOADING
27. Hearing tests at work are necessary.	-0.50
25. Having your hearing tested at work makes you more aware of your hearing.	0.40
20. Hearing tests done at work are useful to both managements and employees.	-0.39
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	0.38
15. The provision of hearing tests is a sign of an employer's concern for the hearing of his employees.	0.38

Firm 2 Principal Components Analysis

Factor 5

ITEM	LOADING
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.51
16. Hearing tests at work should be compulsory.	-0.42
19. It's every employee's right to have his hearing tested.	0.42

Firm 2 Varimax Rotation

Factor 1

ITEM	LOADING
20. Hearing tests done at work are useful to both managements and employees.	0.88
16. Hearing tests at work should be compulsory.	0.75
21. Hearing tests are best left to the National Health Service.	0.47
4. Hearing tests done at work are more valuable to managements than employees.	0.46
3. There is no reason why employees should have their hearing tested at work.	0.42
14. Having your hearing tested at work makes you think about your hearing.	0.40
25. Having your hearing tested at work makes you more aware of your hearing.	0.35
23. People should not be paid for time spent having their hearing tested at work.	0.35

Firm 2 Varimax Rotation

Factor 2

ITEM	LOADING
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.79
2. Hearing tests should not be used to disqualify a person from employment.	-0.72
14. Having your hearing tested at work makes you think about your hearing.	0.55
10. The younger you are, the more useful it is to have your hearing tested.	0.54
19. It's every employee's right to have his hearing tested.	0.50

Firm 2 Varimax Rotation

Factor 3

ITEM	LOADING
8. Hearing tests done at work are useful for some purposes but not for others.	0.77
26. Testing hearing is not a medical problem.	0.57
23. People should not be paid for time spent having hearing tested at work.	0.51
11. Hearing tests should be done by your own doctor and not at work.	-0.50
7. The older you are, the more useful it is to have your hearing tested.	0.45
13. Hearing tests at work encourage people to have medical checkups they might otherwise not have had.	-0.38
14. Having your hearing tested at work makes you think about your hearing.	0.37
4. Hearing tests done at work are more valuable to managements than employees.	-0.36

Firm 2 Varimax Rotation

Factor 4

ITEM	LOADING
11. Hearing tests should be done by your own doctor and not at work.	0.65
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.63
24. Hearing tests done at work are pointless.	0.59
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	0.56
27. Work is just as good a place as any to perform hearing tests.	0.54
23. People should not be paid for time spent having their hearing tested at work.	0.46
5. Having your hearing tested at work makes you worry about your hearing.	-0.42
2. Hearing tests should not be used to disqualify a person from employment.	0.38

Firm 2 Varimax Rotation

Factor 5

ITEM	LOADING
25. Having your hearing tested at work makes you more aware of your hearing.	0.74
7. The older you are, the more useful it is to have your hearing tested.	0.68
3. There is no reason why employees should have their hearing tested at work.	0.65
17. Hearing tests at work are necessary.	-0.55

Firm 2 Quartimax Rotation

Factor 1

ITEM	LOADING
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.81
2. Hearing tests should not be used to disqualify a person from employment.	-0.73
10. The younger you are, the more useful it is to have your hearing tested.	0.60
14. Having your hearing tested at work makes you think about your hearing.	-0.53
19. It's every employee's right to have his hearing tested.	0.52
8. Hearing tests done at work are useful for some purposes but not for others.	0.36

Firm 2 : Quartimax Rotation

Factor 2

ITEM	LOADING
20. Hearing tests done at work are useful to both managements and employees.	0.88
16. Hearing tests at work should be compulsory.	0.75
4. Hearing tests done at work are more valuable to managements than employees.	0.48
21. Hearing tests are best left to the National Health Service.	0.46
3. There is no reason why employees should have their hearing tested at work.	0.43
14. Having your hearing tested at work makes you think about your hearing.	0.39
25. Having your hearing tested at work makes you more aware of your hearing.	0.35

Firm 2 Quartimax Rotation

Factor 3

ITEM	LOADING
8. Hearing tests done at work are useful for some purposes but not for others.	0.76
26. Testing hearing is not a medical problem.	0.57
23. People should not be paid for time spent having their hearing tested at work.	0.52
11. Hearing tests should be done by your own doctor and not at work.	-0.50
7. The older you are, the more useful it is to have your hearing tested.	0.46
14. Having your hearing tested at work makes you think about your hearing.	0.40
13. Hearing tests at work encourage people to have medical checkups they might otherwise not have had.	0.37
4. Hearing tests done at work are more valuable to managements than employees.	-0.36

Firm 2 Quartimax Rotation

Factor 4

ITEM	LOADING
11. Hearing tests should be done by your own doctor and not at work.	0.68
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.67
27. Work is just as good a place as any to perform hearing tests.	0.59
24. Hearing tests done at work are pointless.	0.59
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	0.55
5. Having your hearing tested at work makes you worry about your hearing.	-0.51
23. People should not be paid for time spent having their hearing tested at work.	0.45
2. Hearing tests should not be used to disqualify a person from employment.	0.41

Firm 2 Quartimax Rotation

Factor 5

ITEM	LOADING
25. Having your hearing tested at work makes you more aware of your hearing.	0.75
7. The older you are, the more useful it is to have your hearing tested.	0.68
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	0.65
17. Hearing tests at work are necessary.	-0.55

Firm 2 Equimax Rotation

Factor 1

ITEM	LOADING
25. Having your hearing tested at work makes you more aware of your hearing.	0.74
7. The older you are, the more useful it is to having your hearing tested.	0.69
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	0.65
17. Hearing tests at work are necessary	-0.54

Firm 2 Equimax Rotation

Factor 2

ITEM	LOADING
8. Hearing tests done at work are useful for some purposes but not for others.	0.74
26. Testing hearing is not a medical problem.	0.57
23. People should not be paid for time spent having their hearing tested at work.	0.56
7. The older you are, the more useful it is to have your hearing tested.	0.43

Firm 2 Equimax Rotation

Factor 2 cont'd

ITEM	LOADING
11. Hearing tests should be done by your own doctor and not at work.	-0.43
14. Having your hearing tested at work makes you think about your hearing.	0.37
13. Hearing tests at work encourage people to have medical checkups they might otherwise not have had.	-0.36
4. Hearing tests done at work are more valuable to managements than employees.	-0.35

Firm 2 Equimax Rotation

Factor 3

ITEM	LOADING
20. Hearing tests done at work are useful to both managements and employees.	0.87
16. Hearing tests at work should be compulsory.	0.76
4. Hearing tests done at work are more valuable to managements than employees.	0.45
21. Hearing tests are best left to the National Health Service.	0.45

Firm 2 Equimax Rotation

Factor 3 cont'd

ITEM	LOADING
14. Having your hearing tested at work makes you think about your hearing.	0.40
3. There is no reason why employees should have their hearing tested at work.	0.39

Firm 2 Equimax Rotation

Factor 4

ITEM	LOADING
11. Hearing tests should be done by your own doctor and not at work.	0.67
24. Hearing tests done at work are pointless.	0.62
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.53
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	0.47
23. People should not be paid for time spent having their hearing tested at work.	0.44

Firm 2 Equimax Rotation

Factor 5

ITEM	LOADING
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.77
2. Hearing tests should not be used to disqualify a person from employment.	-0.70
14. Having your hearing tested at work makes you think about your hearing.	-0.55
19. It's every employee's right to have his hearing tested.	0.48
10. The younger you are, the more useful it is to have your hearing tested.	0.45

Firm 2 Equimax Rotation

Factor 6

ITEM	LOADING
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.	0.77
5. Having your hearing tested at work makes you worry about your hearing.	-0.66
11. Hearing tests should be done by your own doctor and not at work.	0.43

Firm 2 Equimax Rotation

Factor 6 cont'd

ITEM	LOADING
27. Work is just as good a place as any to perform hearing tests.	0.41
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.40

WORKERS' AUDIOMETRY QUESTIONNAIRE

FIRM 3

15 RESPONDENTS

Firm 3 Principal Components Analysis

Factor 1

ITEM	LOADING
15. The provision of hearing tests is a sign of an employer's concern for the hearing of his employees.	0.85
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.81
20. Hearing tests done at work are useful to both managements and employees.	0.79
6. By performing hearing tests at work, the emphasis is moved from controlling noise to preserving hearing.	0.71
17. Hearing tests at work are necessary.	0.73
7. The older you are, the more useful it is to have your hearing tested.	0.71
19. It's every employee's right to have his hearing tested.	0.68
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused by work.	0.65
5. Having your hearing tested at work makes you worry about your hearing.	0.61

Firm 3 Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
14. Having your hearing tested at work makes you think about your hearing.	0.61
11. Hearing tests should be done by your own doctor and not at work.	0.61

Firm 3 Principal Components Analysis

Factor 2

ITEM	LOADING
16. Hearing tests at work should be compulsory.	0.85
8. Hearing tests done at work are useful for some purposes but not for others.	-0.79
10. The younger you are, the more useful it is to have your hearing tested.	-0.77
27. Work is just as good a place as any to perform hearing tests.	0.73
3. There is no reason why employees should have their hearing tested at work.	0.64

Firm 3 Varimax Rotation

Factor 1

ITEM	LOADING
10. The younger you are, the more useful it is to have your hearing tested.	0.91
27. Work is just as good a place as any to perform hearing tests.	-0.89
8. Hearing tests done at work are useful for some purposes but not for others.	0.85
16. Hearing tests at work should be compulsory.	-0.82
23. People should not be paid for time spent having their hearing tested at work.	0.74
3. There is no reason why employee should have their hearing tested at work.	-0.65

Firm 3 Varimax Rotation

Factor 2

ITEM	LOADING
14. Having your hearing tested at work makes you think about your hearing.	0.92
25. Having your hearing tested at work makes you more aware of your hearing.	0.89
24. Hearing tests done at work are pointless.	-0.54

Firm 3 Quartimax Rotation

Factor 1

ITEM	LOADING
17. Hearing tests at work are necessary.	0.89
15. The provision of hearing tests is a sign of an employer's concern for the hearing of his employees.	0.84
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.	0.81
20. Hearing tests done at work are useful to both managements and employees.	0.79
19. It's every employee's right to have his hearing tested.	0.79
6. By performing hearing tests at work, the emphasis if moved from controlling noise to preserving hearing.	0.75
1. Conducting hearing tests is the job of the National Health Service, not the employer.	0.75
9. The main purpose of hearing tests done at work is to prevent employees suing their employer for deafness caused at work.	0.72

Firm 3 Quartimax Rotation

Factor 2

ITEM	LOADING
10. The younger you are, the more useful it is to have your hearing tested.	0.93
27. Work is just as good a place as any to perform hearing tests.	-0.88
8. Hearing tests done at work are useful for some purposes but not for others.	0.86
16. Hearing tests at work should be compulsory.	-0.86
23. People should not be paid for time spent having their hearing tested at work.	0.70

Firm 3 Equimax Rotation

Factor 1

ITEM	LOADING
28. Work is just as good a place as any to perform hearing tests.	-0.85
3. There is no reason why employees should have their hearing tested at work.	-0.81
10. The younger you are, the more useful it is to have your hearing tested.	0.79
23. People should not be paid for time spent having their hearing tested at work.	0.79
8. Hearing tests done at work are useful for some purposes but not for others.	0.74

Firm 3 Equimax Rotation

Factor 2

ITEM	LOADING
18. Hearing tests at work encourage managements to take more interest in noise and hearing problems.	0.97
15. The provision of hearing tests is a sign of an employer's concern for the hearing of his employees.	0.73
19. It's every employee's right to have his hearing tested.	0.50

Firm 3 Equimax Rotation

Factor 3

ITEM	LOADING
12. Time spent having your hearing tested at work should be paid at overtime rates.	0.82
4. Hearing tests done at work are more valuable to managements than employees.	-0.77
16. Hearing tests at work should be compulsory.	-0.68

Firm 3 Equimax Rotation

Factor 4

ITEM	LOADING
21. Hearing tests are best left to the National Health Service.	0.71
11. Hearing tests should be done by your own doctor and not at work.	0.69
22. There's no point in testing a woman's hearing at work.	0.65

WORKERS' PERSONAL HEARING PROTECTORS QUESTIONNAIRE

FIRM 1

52 RESPONDENTS

Firm 1 Principal Components Analysis

Factor 1

ITEM	LOADING
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.72
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.69
13. Earmuffs and earplugs are just as useful to both men and women.	0.69
17. Wearing earmuffs makes you look silly.	-0.68
2. Earplugs and earmuffs are dirty.	-0.68
1. Earmuffs and earplugs are a bad thing.	-0.64
15. Earmuffs or earplugs are not much use if you're hard of hearing already.	-0.62
25. Earmuffs spoil your appearance.	-0.60
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	-0.60
20. Wearing earplugs makes you look silly.	-0.58

Firm 1 Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
5. It's never too late to start wearing earmuffs or earplugs.	0.57
28. Every employee has the right to a pair of earmuffs or earplugs.	0.56
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	0.55
9. There's not much point in wearing earplugs or earmuffs, if you've got good hearing.	-0.54
3. Hearing loss at work is unavoidable.	-0.52
16. Earmuffs and earplugs are comfortable to wear.	0.48
24. It's absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.	0.48
29. It's the employer's job to protect the hearing of his employees.	0.48
14. People are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	0.40

Firm 1 Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
30. When it comes to wearing earplugs or earmuffs, it does'nt matter what sex you are.	0.39
32. It's reasonable to expect men to wear earmuffs or earplugs, but not women.	-0.39
6. The wearing of earplugs or earmuffs should be made compulsory.	0.36
31. Providing earplugs or earmuffs is a sign of the management's concern for the hearing of its employees.	0.36

Firm 1 Principal Components Analysis

Factor 2

ITEM	LOADING
4. Wearing earmuffs or earplugs is a matter of taste.	-0.68
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	-0.63
12. It should be up to the individual to decide whether or no to wear earplugs or earmuffs provided.	-0.62

Firm 1 Principal Components Analysis

Factor 2 cont'd

ITEM	LOADING
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	-0.62
19. Earmuffs or earplugs should'nt be necessary because machines should be made quieter instead.	-0.56
6. The wearing of earplugs or earmuffs should be made compulsory.	0.49
20. Wearing earplugs makes you look silly.	-0.49
18. If a woman goes deaf at work, it's her employer's fault.	-0.46
17. Wearing earmuffs makes you look silly.	-0.41
25. Earmuffs spoil your appearance.	-0.40
13. Earmuffs and earplugs are just as useful to both men and women.	-0.39
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	0.36

Firm 1 Principal Components Analysis

Factor 3

ITEM	LOADING
22. An employer is responsible for everything that happens on his premises, including hearing loss.	-0.65
32. It's reasonable to expect men to wear earmuffs or earplugs, but not women.	-0.60
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	0.52
6. The wearing of earplugs or earmuffs should be made compulsory.	-0.50
26. If a woman goes deaf at work, it's her own fault.	0.48
18. If a woman goes deaf at work, it's her employer's fault.	-0.44
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	-0.42
29. It's the employer's job to protect the hearing of his employees.	-0.38

Firm 1 Principal Components Analysis

Factor 4

ITEM	LOADING
24. It's absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.	-0.62
4. Wearing earmuffs or earplugs is a matter of taste.	0.44
16. Earmuffs and earplugs are comfortable to wear.	0.42
28. Every employee has the right to a pair of earmuffs or earplugs.	-0.42
26. If a woman goes deaf at work, it's her own fault.	-0.39
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	

Firm 1 Principal Components Analysis

Factor 5

ITEM	LOADING
1. Earmuffs and earplugs are a bad thing.	-0.57
2. Earplugs and earmuffs are dirty.	-0.53

Firm 1 Principal Components Analysis

Factor 5 cont'd

ITEM	LOADING
18. If a woman goes deaf at work, it's her employer's fault.	0.50
5. It's never too late to start wearing earmuffs or earplugs.	-0.48

Firm 1 Varimax Rotation

Factor 1

ITEM	LOADING
28. Every employee has the right to a pair of earmuffs or earplugs.	0.86
13. Earmuffs and earplugs are just as useful to both men and women.	0.78
5. It's never too late to start wearing earmuffs or earplugs.	0.65
24. It's absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.	0.60
9. There's not much point in wearing earplugs or earmuffs, if you've got good hearing.	-0.59
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.50
26. If a woman goes deaf at work, it's her own fault.	0.42
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.40

Firm 1 Varimax Rotation

Factor 2

ITEM	LOADING
25. Earmuffs spoil your appearance.	-0.87
17. Wearing earmuffs makes you look silly.	-0.85
20. Wearing earplugs makes you look silly.	-0.82
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	-0.51

Firm 1 Varimax Rotation

Factor 3

ITEM	LOADING
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	0.87
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	0.87
4. Wearing earmuffs or earplugs is a matter of taste.	0.71
6. The wearing of earplugs or earmuffs should be made compulsory.	-0.62

Firm 1 **Varimax Rotation**

Factor 3 cont'd

ITEM	LOADING
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	-0.40
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	0.38

Firm 1 **Varimax Rotation**

Factor 4

ITEM	LOADING
16. Earmuffs and earplugs are comfortable to wear.	0.76
14. People are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	0.66
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	-0.65
6. The wearing of earplugs or earmuffs should be made compulsory.	0.38

Firm 1 Varimax Rotation

Factor 5

ITEM	LOADING
2. Earplugs and earmuffs are dirty.	-0.80
1. Earmuffs and earplugs are a bad thing.	-0.77
3. Hearing loss at work is unavoidable.	-0.59
18. If a woman goes deaf at work, it's her employer's fault.	0.46
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.43

Firm 1 Varimax Rotation

Factor 6

ITEM	LOADING
32. It's reasonable to expect men to wear earmuffs or earplugs, but not women.	-0.82
18. If a woman goes deaf at work, it's her employer's fault.	-0.62
22. An employer if responsible for everything that happens on his premises, including hearing loss.	-0.60
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	-0.38

Firm 1 Varimax Rotation

Factor 7

ITEM	LOADING
15. Earmuffs or earplugs are not much use if you're hard of hearing already.	0.88
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	0.80
5. It's never too late to start wearing earmuffs or earplugs.	-0.40
3. Hearing loss at work is unavoidable.	0.40

Firm 1 Promax Rotation

Factor 1

ITEM	LOADING
13. Earmuffs and earplugs are just as useful to both men and women.	0.83
28. Every employee has the right to a pair of earmuffs or earplugs.	0.83
9. There's not much point in wearing earplugs or earmuffs if you've got bad hearing.	-0.69
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.68
5. It's never too late to start wearing earmuffs or earplugs.	0.67
24. It's absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.	0.66
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.59
1. Earmuffs and earplugs are a bad thing.	-0.44
27. It absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	0.39

Firm 1 Promax Rotation

Factor 1 cont'd

ITEM	LOADING
26. If a woman does deaf at work, it's her own fault.	0.38
2. Earplugs and earmuffs are dirty.	-0.36

Firm 1 Promax Rotation

Factor 2

ITEM	LOADING
25. Earmuffs spoil your appearance.	-0.89
17. Wearing earmuffs makes you look silly.	-0.87
20. Wearing earplugs makes you look silly.	-0.84
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	-0.62
6. The wearing of earplugs or earmuffs should be made compulsory.	0.38
4. Wearing earmuffs or earplugs is a matter of taste.	-0.36

Firm 1 Promax Rotation

Factor 3

ITEM	LOADING
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	0.86
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	0.84
4. Wearing earmuffs or earplugs is a matter of taste.	0.74
6. The wearing of earplugs or earmuffs should be made compulsory.	-0.70
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	-0.51
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	0.44

Firm 1 Promax Rotation

Factor 4

ITEM	LOADING
16. Earmuffs and earplugs are comfortable to wear.	0.83
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	-0.71
14. People who are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	0.62
6. The wearing of earplugs or earmuffs should be made compulsory.	0.51
17. Wearing earmuffs make you look silly.	-0.45
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	0.43
20. Wearing earplugs make you look silly.	-0.40
29. It's the employer's job to protect the hearing of his employees.	0.38
22. An employer is responsible for everything that happens on his premises, including hearing loss.	0.37
15. Earmuffs or earplugs are not much use if you're hard of hearing already.	-0.36

Firm 1 Promax Rotation

Factor 5

ITEM	LOADING
2. Earplugs and earmuffs are dirty.	-0.87
1. Earmuffs and earplugs are a bad thing.	-0.83
3. Hearing loss at work is unavoidable.	-0.63
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.57
18. If a woman goes deaf at work, it's her employer's fault.	0.39
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.39
28. Every employee has the right to a pair of earmuffs or earplugs.	0.37

Firm 1 Promax Rotation

Factor 6

ITEM	LOADING
32. It's reasonable to expect men to wear earmuffs or earplugs, but not women.	-0.81
18. If a woman goes deaf at work, it's her employer's fault.	-0.65
22. An employer is responsible for everything that happens on his premises, including hearing loss.	-0.61
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	-0.43
19. Earmuffs and earplugs should'nt be necessary because machines should be made quieter instead.	-0.39

Firm 1 Promax Rotation

Factor 7

ITEM	LOADING
15. Earmuffs or earplugs are not much use if you're hard of hearing already.	0.92
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	0.91
5. It's never too late to start wearing earmuffs or earplugs.	-0.56

Firm 1 Promax Rotation

Factor 7 cont'd

ITEM	LOADING
13. Earmuffs and earplugs are just as useful to both men and women.	-0.54
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	0.53
3. Hearing loss at work is unavoidable.	0.48
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	0.42
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	0.38

Firm 1 Promax Rotation

Factor 8

ITEM	LOADING
31. Providing earplugs or earmuffs is a sign of the management's concern for the hearing of it's employees.	-0.78
14. People are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	0.39

Firm 1 Promax Rotation

Factor 9

ITEM	LOADING
24. It's absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.	-0.72
30. When it comes to wearing earplugs or earmuffs it does'nt matter what sex you are.	-0.71
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	-0.70
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	0.51
7. There's no point in wearing earmuffs or earplugs if you've been working in noise for a long time.	0.49
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	0.46
2. Earplugs and earmuffs are dirty.	0.41

Firm 1 Promax Rotation

Factor 10

ITEM	LOADING
10. Earmuffs and earplugs may or may not be useful.	-0.81
19. Earmuffs or earplugs should'nt be necessary because machines should be made quieter instead.	0.64
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	-0.45

Firm 1 Promax Rotation

Factor 11

ITEM	LOADING
29. It's the employer's job to protect the hearing of his employees.	-0.73
26. If a woman goes deaf at work, it's her own fault.	0.59
22. An employer is responsible for everything that happens on his premises, including hearing loss.	-0.44
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	0.42

WORKERS' PERSONAL HEARING PROTECTORS QUESTIONNAIRE

FIRM 2

51 RESPONDENTS

Firm 2 Principal Components Analysis

Factor 1

ITEM	LOADING
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.73
26. If a woman goes deaf at work, it's her own fault.	-0.69
20. Wearing earplugs makes you look silly.	-0.68
15. Earmuffs or earplugs are not much use if you're hard of hearing already.	-0.63
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	-0.61
19. Earmuffs or earplugs should'nt be necessary because machines should be made quieter instead.	-0.57
22. An employer is responsible for everything that happens on his premises, including hearing loss.	-0.53
2. Earplugs and earmuffs are dirty.	0.53
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	0.50

Firm 2 Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	-0.49
1. Earmuffs and earplugs are a bad thing.	-0.46
30. When it comes to wearing earplugs or earmuffs, it does'nt matter what sex you are.	-0.39
10. Earmuffs and earplugs may or may not be useful.	-0.38

Firm 2 Principal Components Analysis

Factor 2

ITEM	LOADING
5. It's never too late to start wearing earmuffs or earplugs.	-0.65
6. The wearing of earplugs or earmuffs should be made compulsory.	-0.63
28. Every employee has the right to a pair of earmuffs or earplugs.	-0.55
32. It's reasonable to expect men to wear earmuffs or earplugs, but not women.	-0.55

Firm 2

Principal Components Analysis

Factor 2 cont'd

ITEM	LOADING
31. Providing earplugs or earmuffs is a sign of the management's concern for the hearing of it's employees.	-0.54
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.52
25. Earmuffs spoil your appearance.	0.51
17. Wearing earmuffs makes you look silly.	-0.46
29. It's the employer's job to protect the hearing of his employees.	-0.45
13. Earmuffs and earplugs are just as useful to both men and women.	0.38
14. People who are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	0.38
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	-0.37
3. Hearing loss at work is unavoidable.	-0.36
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	-0.36

Firm 2

Principal Components Analysis

Factor 3

ITEM	LOADING
4. Wearing earmuffs or earplugs is a matter of taste.	0.72
14. People are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	0.66
13. Earmuffs and earplugs are just as useful to both men and women.	0.56
17. Wearing earmuffs makes you look silly.	0.52
10. Earmuffs and earplugs may or may not be useful.	0.48
29. It's the employer's job to protect the hearing of his employees.	0.43
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	-0.39
32. It's reasonable to expect men to wear earmuffs or earplugs, but not women.	
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	-0.39
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.39
25. Earmuffs spoil your appearance.	0.36

Firm 2

Principal Components Analysis

Factor 4

ITEM	LOADING
18. If a woman goes deaf at work, it's her employer's fault.	0.66
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	0.57
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	0.56
19. Earmuffs or earplugs should'nt be necessary because machines should be made quieter instead.	0.47
2. Earplugs and earmuffs are dirty.	0.46
3. Hearing loss at work is unavoidable.	-0.42
30. When it comes to wearing earplugs or earmuffs, it does'nt matter what sex you are.	0.42

Firm 2

Principal Components Analysis

Factor 5

ITEM	LOADING
24. It's absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.	0.64
3. Hearing loss at work is unavoidable.	0.43
28. Every employee has the right to a pair of earmuffs or earplugs.	0.42
6. The wearing of earplugs or earmuffs should be made compulsory.	0.41
25. Earmuffs spoil your appearance.	0.41
2. Earplugs and earmuffs are dirty.	0.40
31. Providing earplugs or earmuffs is a sign of the management's concern for the hearing of it's employees.	-0.39
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	-0.38

Firm 2 Principal Components Analysis

Factor 6

ITEM	LOADING
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	-0.48
24. It's absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.	-0.43
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	-0.40
16. Earmuffs and earplugs are comfortable to wear.	-0.38

Firm 2 Principal Components Analysis

Factor 7

ITEM	LOADING
30. When it comes to wearing earplugs or earmuffs, it does'nt matter what sex you are.	-0.52
3. Hearing loss at work is unavoidable.	-0.39
13. Earmuffs and earplugs are just as useful to both men and women.	0.38

Firm 2 Varimax Rotation

Factor 1

ITEM	LOADING
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.82
26. If a woman goes deaf at work, it's her own fault.	-0.73
24. It's absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.	0.70
20. Wearing earplugs makes you look silly.	-0.59
19. Earmuffs or earplugs should'nt be necessary because machines should be made quieter instead.	-0.57
2. Earplugs and earmuffs are dirty.	0.46
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	-0.43
4. Wearing earmuffs or earplugs is a matter of taste.	0.35

Firm 2 Varimax Rotation

Factor 2

ITEM	LOADING
31. Providing earplugs or earmuffs is a sign of the management's concern for the hearing of it's employees.	-0.82
32. It's reasonable to expect men to wear earmuffs or earplugs, but not women.	-0.69
4. Wearing earmuffs or earplugs is a matter of taste.	-0.63
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	-0.61
17. Wearing earmuffs makes you look silly.	-0.48
5. It's never too late to start wearing earmuffs or earplugs.	-0.45

Firm 2 Varimax Rotation

Factor 3

ITEM	LOADING
14. People are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	0.88
13. Earmuffs and earplugs are just as useful to both men and women.	0.74

Firm 2 **Varimax Rotation**

Factor 3 cont'd

ITEM	LOADING
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	-0.72
25. Earmuffs spoil your appearance.	0.71
10. Earmuffs and earplugs may or may not be useful	0.41

Firm 2 **Varimax Rotation**

Factor 4

2. Earplugs and earmuffs are dirty.	0.75
18. If a woman goes deaf at work, it's her employer's fault.	0.70
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	0.61
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	0.56
6. The wearing of earplugs or earmuffs should be made compulsory.	0.55
5. It's never too late to start wearing earmuffs or earplugs.	0.36

Firm 2 Varimax Rotation

Factor 5

ITEM	LOADING
3. Hearing loss at work is unavoidable.	0.81
29. It's the employer's job to protect the hearing of his employees.	0.65
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	0.61
6. The wearing of earplugs or earmuffs should be made compulsory.	0.60
28. Every employee has the right to a pair of earmuffs or earplugs.	0.40

Firm 2 Varimax Rotation

Factor 6

ITEM	LOADING
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	-0.86
15. Earmuffs or earplugs are not much use if you're hard of hearing.	-0.80
16. Earmuffs and earplugs are comfortable to wear.	-0.64

Firm 2 Varimax Rotation

Factor 6 cont'd

ITEM	LOADING
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	-0.50
19. Earmuffs or earplugs should'nt be necessary because machines should be made quieter instead.	-0.39

Firm 2 Varimax Rotation

Factor 7

ITEM	LOADING
30. When it comes to wearing earplugs or earmuffs, it does'nt matter what sex you are.	-0.77
20. Wearing earplugs makes you look silly.	-0.48
13. Earmuffs and earplugs are just as useful to both men and women.	0.43

Firm 2 Varimax Rotation

Factor 8

ITEM	LOADING
22. An employer is responsible for everything that happens on his premises, including hearing loss.	-0.73
28. Every employee has the right to a pair of earmuffs or earplugs.	-0.57
17. Wearing earmuffs makes you look silly.	-0.54

Firm 2 Promax Rotation

Factor 1

ITEM	LOADING
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.83
26. If a woman goes deaf at work, it's her own fault.	-0.71
24. It's absolutely essential that earmuffs or earplugs should be provided whenever working conditions are noisy.	0.68
19. Earmuffs or earplugs should'nt be necessary because machines should be made quieter instead.	-0.65
20. Wearing earplugs makes you look silly.	-0.56
2. Earplugs and earmuffs are dirty.	0.42
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibilty for protecting hearing onto the workers.	-0.41
4. Wearing earmuffs or earplugs is a matter of taste.	0.38
22. An employer is responsible for everything that happens on his premises, including hearing loss.	-0.35

Firm 2 Promax Rotation

Factor 2

ITEM	LOADING
31. Providing earplugs or earmuffs is a sign of the management's concern for the hearing of it's employees.	-0.80
32. It's reasonable to expect me to wear earmuffs or earplugs, but not women.	-0.67
4. Wearing earmuffs or earplugs is a matter of taste.	-0.64
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	-0.54
17. Wearing earmuffs makes you look silly.	-0.47
5. It's never too late to start wearing earmuffs or earplugs.	-0.46
19. Earmuffs or earplugs should'nt be necessary because machines should be made quieter instead.	0.40
29. It's the employer's job to protect the hearing of his employees.	-0.38

Firm 2 Promax Rotation

Factor 3

ITEM	LOADING
14. People are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	0.86
13. Earmuffs and earplugs are just as useful to both men and women.	0.73
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	-0.70
25. Earmuffs spoil your appearance.	0.69
10. Earmuffs and earplugs may or may not be useful.	0.53
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.36

Firm 2 Promax Rotation

Factor 4

ITEM	LOADING
2. Earplugs and earmuffs are dirty.	0.74
18. If a woman goes deaf at work, it's her employer's fault.	0.63
6. The wearing of earplugs or earmuffs should be made compulsory.	0.60
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	0.56
27. It's absolutely essential that earplugs or earmuffs should be worn whenever working conditions are noisy.	0.55
10. Earmuffs and earplugs may or may not be useful.	0.43
5. It's never too late to start wearing earmuffs or earplugs.	0.39

Firm 2 Promax Rotation

Factor 5

ITEM	LOADING
3. Hearing loss at work is unavoidable.	0.73
29. It's the employer's job to protect the hearing of his employees.	0.72
6. The wearing of earplugs or earmuffs should be made compulsory.	0.68
23. The provision of earplugs or earmuffs is a ploy used by managements to shift responsibility for protecting hearing onto the workers.	0.55
28. Every employee has the right to a pair of earmuffs or earplugs.	
5. It's never too late to start wearing earmuffs or earplugs.	

Firm 2 Promax Rotation

Factor 6

ITEM	LOADING
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	-0.85
15. Earmuffs or earplugs are not much use if you're hard of hearing already.	-0.78
16. Earmuffs and earplugs are comfortable to wear.	-0.67

Firm 2 Promax Rotation

Factor 6 cont'd

ITEM	LOADING
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	-0.51
7. There's no point in wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.38

Firm 2 Promax Rotation

Factor 7

ITEM	LOADING
30. When it comes to wearing earplugs or earmuffs, it does'nt matter what sex you are.	-0.76
20. Wearing earplugs makes you look silly.	-0.54
13. Earmuffs and earplugs are just as useful to both men and women.	0.43

Firm 2 Promax Rotation

Factor 8

ITEM	LOADING
22. An employer is responsible for everything that happens on his premises, including hearing loss.	-0.74
17. Wearing earmuffs makes you look silly.	-0.61

Firm 2 Promax Rotation

Factor 8 cont'd

ITEM	LOADING
28. Every employee has the right to a pair of earmuffs or earplugs.	-0.59
20. Wearing earplugs makes you look silly.	-0.48
16. Earmuffs and earplugs are comfortable to wear.	-0.39

WORKERS' PERSONAL HEARING PROTECTORS QUESTIONNAIRE

FIRM 3

15 RESPONDENTS

Firm 3 Principal Components Analysis

Factor 1

ITEM	LOADING
3. Hearing loss at work is unavoidable.	-0.80
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.79
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	-0.74
7. There's no point in wearing earmuffs if you've been working in noise for a long time.	-0.73
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	-0.70
1. Earmuffs and earplugs are a bad thing.	-0.69
15. Earmuffs or earplugs are not much use if you're hard of hearing already.	-0.64
5. It's never too late to start wearing earmuffs or earplugs.	0.61

Firm 3 Principal Components Analysis

Factor 2

ITEM	LOADING
29. It's the employer's job to protect the hearing of his employees.	0.80
18. If a woman goes deaf at work, it's her employer's fault.	0.64
32. It's reasonable to expect men to wear earmuffs or earplugs, but not women.	-0.63

Firm 3 Varimax Rotation

Factor 1

ITEM	LOADING
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	-0.93
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	-0.92
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.90
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.89
1. Earmuffs and earplugs are a bad thing.	-0.85
5. It's never too late to start wearing earmuffs or earplugs.	0.82
13. Earmuffs and earplugs are just as useful to both men and women.	0.76

Firm 3 Varimax Rotation

Factor 2

ITEM	LOADING
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	-0.86
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	-0.86
10. Earmuffs and earplugs may or may not be useful.	0.71
14. People are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	-0.69

Firm 2 Varimax Rotation

Factor 3

ITEM	LOADING
16. Earmuffs and earplugs are comfortable to wear.	0.94
2. Earplugs and earmuffs are dirty.	-0.90
3. Hearing loss at work is unavoidable.	-0.60

Firm 3 Varimax Rotation

Factor 4

ITEM	LOADING
25. Earmuffs spoil your appearance.	0.90
17. Wearing earmuffs makes you look silly.	0.86
20. Wearing earplugs makes you look silly.	0.75

Firm 3 Varimax Rotation

Factor 5

ITEM	LOADING
22. An employer is responsible for everything that happens on his premises, including hearing loss.	-0.89
15. Earmuffs or earplugs are not much use if you're hard of hearing already.	0.76
29. It's the employer's job to protect the hearing of his employees.	-0.61

Firm 3 Promax Rotation

Factor 1

ITEM	LOADING
21. It's too much to expect people to wear earmuffs or earplugs in addition to all the other equipment they have to wear already.	-0.93
7. There's no point wearing earmuffs or earplugs if you've been working in noise for a long time.	-0.92
9. There's not much point in wearing earplugs or earmuffs if you've got good hearing.	-0.92
11. There's no point in wearing earplugs or earmuffs if you've got bad hearing.	-0.88
1. Earmuffs and earplugs are a bad thing.	-0.87
5. It's never too late to start wearing earmuffs or earplugs.	0.83
13. Earmuffs and earplugs are just as useful to both men and women.	0.74

Firm 3 Promax Rotation

Factor 2

ITEM	LOADING
8. It's up to the individual to decide whether or not to wear earmuffs or earplugs that have been provided.	-0.90
12. It should be up to the individual to decide whether or not to wear earplugs or earmuffs provided.	-0.89
14. People are so used to wearing protective equipment that one more item such as earplugs or earmuffs would'nt make any difference.	-0.71
6. The wearing of earplugs or earmuffs should be made compulsory.	0.63

Firm 3 Promax Rotation

Factor 3

ITEM	LOADING
16. Earmuffs and earplugs are comfortable to wear.	0.95
2. Earplugs and earmuffs are dirty.	-0.93
3. Hearing loss at work is unavoidable.	-0.67

Firm 3 Promax Rotation

Factor 4

ITEM	LOADING
17. Wearing earmuffs makes you look silly.	0.84
25. Earmuffs spoil your appearance.	0.83
20. Wearing earplugs makes you look silly.	0.82

Firm 3 Promax Rotation

Factor 5

ITEM	LOADING
22. An employer is responsible for everything that happens on his premises, including hearing loss.	-0.88
29. It's the employer's job to protect the hearing of his employees.	-0.75
15. Earmuffs or earplugs are not much use if you're hard of hearing already.	0.73

INDUSTRIAL MEDICAL OFFICERS' QUESTIONNAIRE

MEDICAL OFFICERS PERFORMING AUDIOMETRY

126 RESPONDENTS

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 1

ITEM	LOADING
2. Audiometry is an essential part of any hearing conservation programme.	-0.81
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	-0.72
24. Audiometry and hearing protection are inseparable.	-0.68
13. Firms should be compelled by law to periodically test the hearing of their employees.	-0.66
12. Audiometry and noise control are inseparable.	-0.64
17. The value of audiometry in industry is unestablished.	0.62
16. Where a firm has a programme of medical screening audiometry should be a part of that programme.	-0.60
22. Audiometry encourages managements to take an interest in the problem of noise at work.	-0.57
5. Audiometry is not advisable in an industrial situation.	0.57
7. Audiometry is an expansive toy for occupational physicians to play with.	0.54

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	-0.54
10. Money spent on audiometry would be better spent on noise control.	0.52
1. Industrial audiometry is a useful diagnostic tool.	-0.51
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	-0.50
27. Audiometry is relatively inexpensive.	-0.48
3. Assessing a worker's hearing ability is not necessary in order to protect it.	0.47
9. Industrial audiometry is basically anti-worker.	0.47
21. Audiometry encourages the use of hearing protectors by workers.	-0.46
23. Not enough is known about industrial audiometry to make statements about its usefulness.	0.38
20. Audiometry is an adjunct to a hearing conservation programme and no more.	0.36

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	-0.35
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	-0.33
6. Audiometry has no effect on industrial relations.	0.31
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	-0.27

Principal Components Analysis

Factor 2

ITEM	LOADING
21. Audiometry encourages the use of hearing protectors by workers.	-0.62
12. Audiometry and noise control are inseparable.	0.41
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	-0.40
23. Not enough is known about industrial audiometry to make statements about its usefulness.	0.31

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 2 cont'd

ITEM	LOADING
3. Assessing a worker's hearing ability is not necessary in order to protect it.	-0.31
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	-0.29
24. Audiometry and hearing protection are inseparable.	-0.29
22. Audiometry encourages managements to take an interest in the problem of noise at work.	-0.28
9. Industrial audiometry is basically anti-worker.	0.25

Principal Components Analysis

Factor 3

ITEM	LOADING
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	-0.41
15. Audiometry can never prevent occupational deafness.	0.39
17. The value of audiometry in industry is unestablished.	-0.37

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 3 cont'd

ITEM	LOADING
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise-induced hearing-loss.	-0.34
10. Money spent on audiometry would be better spent on noise control.	-0.31
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	-0.30
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	-0.28

Principal Components Analysis

Factor 4

7. Audiometry is an expensive toy for occupational physicians to play with.	0.35
27. Audiometry is relatively inexpensive.	-0.34
9. Industrial audiometry is basically anti-worker.	0.33
15. Audiometry can never prevent occupational deafness.	-0.32
21. Audiometry encourages the use of hearing protectors by workers.	0.27

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 5

ITEM	LOADING
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.36
17. The value of audiometry in industry is unestablished.	0.27
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	-0.25

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Varimax Rotation

Factor 1

ITEM	LOADING
12. Audiometry and noise control are inseparable.	0.71
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.68
2. Audiometry is an essential part of any hearing conservation programme.	0.67
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.66
16. Where a firm has a programme of medical screening audiometry should be a part of that programme.	0.61
24. Audiometry and hearing protection are inseparable.	0.56
17. The value of audiometry in industry is unestablished.	-0.52
10. Money spent on audiometry would be better spent on noise control.	-0.43
1. Industrial audiometry is a useful diagnostic tool.	0.42
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.42
20. Audiometry is an adjunct to a hearing conservation programme and no more.	-0.34

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Varimax Rotation

Factor 1 cont'd

ITEM	LOADING
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.32
27. Audiometry is relatively inexpensive.	0.30
5. Audiometry is not advisable in an industrial situation.	-0.27
3. Assessing a worker's hearing ability is not necessary in order to protect it.	-0.26
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.25

Varimax Rotation

Factor 2

ITEM	LOADING
17. The value of audiometry in industry is unestablished.	0.61
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	-0.55
23. Not enough is known about industrial audiometry to make statements about its usefulness.	0.50
6. Audiometry has no effect on industrial relations.	0.41

Varimax Rotation

Factor 2 cont'd

ITEM	LOADING
21. Audiometry encourages the use of hearing protectors by workers.	-0.40
22. Audiometry encourages managements to take an interest in the problem of noise at work.	-0.30

Varimax Rotation

Factor 3

9. Industrial audiometry is basically anti-worker.	-0.63
7. Audiometry is an expensive toy for occupational physicians to play with.	-0.62
5. Audiometry is not advisable in an industrial situation.	-0.48
2. Audiometry is an essential part of any hearing conservation programme.	0.45
27. Audiometry is relatively inexpensive.	0.44
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.35
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.25

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Varimax Rotation

Factor 3 cont'd

ITEM	LOADING
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.24

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Quartimax Rotation

Factor 1

ITEM	LOADING
2. Audiometry is an essential part of any hearing conservation programme.	0.84
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.76
12. Audiometry and noise control are inseparable.	0.72
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.69
24. Audiometry and hearing protection are inseparable.	0.69
16. Where a firm has a programme of medical screening audiometry should be a part of that programme.	0.64
17. The value of audiometry in industry is unestablished.	-0.58
10. Money spent on audiometry would be better spent on noise control.	-0.56
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.52
1. Industrial audiometry is a useful diagnostic tool.	0.49

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Quartimax Rotation

Factor 1 cont'd

ITEM	LOADING
5. Audiometry is not advisable in an industrial situation.	-0.49
3. Assessing a worker's hearing ability is not necessary in order to protect it.	-0.46
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.44
7. Audiometry is an expensive toy for occupational physicians to play with.	-0.41
20. Audiometry is an adjunct to a hearing conservation programme and no more.	-0.41
9. Industrial audiometry is basically anti-worker.	-0.36
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.34
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.27
21. Audiometry encourages the use of hearing protectors by workers.	0.25

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Quartimax Rotation

Factor 1 cont'd

ITEM	LOADING
23. Not enough is known about industrial audiometry to make statements about its usefulness.	-0.24

Quartimax Rotation

Factor 2

ITEM	LOADING
21. Audiometry encourages the use of hearing protectors by workers.	0.70
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.51
23. Not enough is known about industrial audiometry to make statements about its usefulness.	-0.48
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.43
17. The value of audiometry in industry is unestablished.	-0.42
6. Audiometry has no effect of industrial relations.	-0.41
25. Not many people in industry care very much about audiometry.	-0.28
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.27

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Quartimax Rotation

Factor 3

ITEM	LOADING
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.50
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise-induced hearing-loss.	0.40
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	0.32
10. Money spent on audiometry would be better spent on noise control.	0.30
24. Audiometry and hearing protection are inseparable.	0.27
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.27

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Equimax Rotation

Factor 1

ITEM	LOADING
12. Audiometry and noise control are inseparable.	0.70
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.46
15. Audiometry can never prevent occupational deafness.	-0.44
24. Audiometry and hearing protection are inseparable.	0.39
1. Industrial audiometry is a useful diagnostic tool.	0.38
2. Audiometry is an essential part of any hearing conservation programme.	0.27
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.30
16. Where a firm has a programme of medical screening audiometry should be a part of that programme.	0.28
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.27

MEDICAL OFFICERS PERFORMING AUDIOMETRY

Equimax Rotation

Factor 2

ITEM	LOADING
21. Audiometry encourages the use of hearing protectors by workers.	0.80
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.52
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.50
1. Industrial audiometry is a useful diagnostic tool.	0.29
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.24

MEIDCAL OFFICERS PERFORMING AUDIOMETRY

Equimax Rotation

Factor 3

ITEM	LOADING
9. Industrial audiometry is basically anti-worker.	-0.62
7. Audiometry is an expensive toy for occupational physicians to play with.	-0.61
5. Audiometry is not advisable in an industrial situation.	-0.48
2. Audiometry is an essential part of any hearing conservation programme.	0.45
27. Audiometry is relatively inexpensive.	0.44
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.31
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.26
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.24

INDUSTRIAL MEDICAL OFFICERS' QUESTIONNAIRE

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

108 RESPONDENTS

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 1

ITEM	LOADING
2. Audiometry is an essential part of any hearing conservation programme.	-0.74
12. Audiometry and noise control are inseparable.	-0.72
24. Audiometry and hearing protection are inseparable.	-0.72
13. Firms should be compelled by law to periodically test the hearing of their employees.	-0.71
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	-0.70
5. Audiometry is not advisable in an industrial situation.	0.66
16. Where a firm has a programme of medical screening audiometry should be a part of that programme.	-0.66
10. Money spent on audiometry would be better spent on noise control.	0.65
17. The value of audiometry in industry is unestablished.	0.65
7. Audiometry is an expensive toy for occupational physicians to play with.	0.63

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
1. Industrial audiometry is a useful diagnostic tool.	-0.60
22. Audiometry encourages managements to take an interest in the problem of noise at work.	-0.57
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	-0.55
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	-0.50
23. Not enough is known about industrial audiometry to make statements about its usefulness.	0.49
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	-0.45
3. Assessing a worker's hearing ability is not necessary in order to protect it.	0.41
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	-0.40
20. Audiometry is an adjunct to a hearing conservation programme and no more.	0.38

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
21. Audiometry encourages the use of hearing protectors by workers.	-0.38
27. Audiometry is relatively inexpensive.	-0.33
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	-0.32
15. Audiometry can never prevent occupational deafness.	0.28
9. Industrial audiometry is basically anti-worker.	0.25

Principal Components Analysis

Factor 2

ITEM	LOADING
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.47
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.45
6. Audiometry has no effect on industrial relations.	-0.38
21. Audiometry encourages the use of hearing protectors by workers.	

Principal Components Analysis

Factor 2 cont'd

ITEM	LOADING
20. Audiometry is an adjunct to a hearing conservation programme and no more.	0.30
25. Not many people in industry care very much about audiometry.	-0.28

Principal Components Analysis

Factor 3

ITEM	LOADING
5. Audiometry is not advisable in an industrial situation.	-0.49
23. Not enough is known about industrial audiometry to make statements about its usefulness.	-0.40
12. Audiometry and noise control are inseparable.	-0.32
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	-0.32
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing	-0.29
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Principal Components Analysis

Factor 4

ITEM	LOADING
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	0.52
15. Audiometry can never prevent occupational deafness.	-0.43
27. Audiometry is relatively inexpensive.	-0.37
20. Audiometry is an adjunct to a hearing conservation programme and no more.	-0.32
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise-induced hearing-loss.	0.30
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	-0.29

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Varimax Rotation

Factor 1

ITEM	LOADING
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.63
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.55
16. Where a firm has a programme of medical screening audiometry should be a part of that programme.	0.50
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.49
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.36
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.36
24. Audiometry and hearing protection are inseparable.	0.31

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Varimax Rotation

Factor 2

ITEM	LOADING
5. Audiometry is not advisable in an industrial situation.	-0.69
7. Audiometry is an expensive toy for occupational physicians to play with.	-0.56
23. Not enough is known about industrial audiometry to make statements about its usefulness.	-0.55
27. Audiometry is relatively inexpensive.	0.49
2. Audiometry is an essential part of any hearing conservation programme.	0.48
9. Industrial audiometry is basically anti-worker.	-0.47
17. The value of audiometry in industry is unestablished.	-0.45
10. Money spent on audiometry would be better spent on noise control.	-0.43
1. Industrial audiometry is a useful diagnostic tool.	0.43
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.38

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Varimax Rotation

Factor 2 cont'd

ITEM	LOADING
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.37
16. Where a firm has a programme of medical screening, audiometry should be part of that programme.	0.29
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.27

Varimax Rotation

Factor 3

ITEM	LOADING
12. Audiometry and noise control are inseparable.	0.71
24. Audiometry and hearing protection are inseparable.	0.65
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.62
20. Audiometry is an adjunct to a hearing conservation programme and no more.	-0.61
10. Money spent on audiometry would be better spent on noise control.	-0.54
2. Audiometry is an essential part of any hearing conservation programme.	0.51

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Varimax Rotation

Factor 3 cont'd

ITEM	LOADING
3. Assessing a worker's hearing ability is not necessary in order to protect it.	-0.46
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.	0.45
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.42
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.41
17. The value of audiometry in industry is unestablished.	-0.38
15. Audiometry can never prevent occupational deafness.	-0.33
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	0.30
7. Audiometry is an expensive toy for occupational physicians to play with.	-0.29
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.27
5. Audiometry is not advisable in an industrial situation.	-0.27

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Varimax Rotation

Factor 4

ITEM	LOADING
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.80
21 Audiometry encourages the use of hearing protectors by workers.	0.57
12. Audiometry and noise control are inseparable.	0.40
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.36
23. Not enough is known about industrial audiometry to make statements about its usefulness.	-0.29

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Quartimax Rotation

Factor 1

ITEM	LOADING
2. Audiometry is an essential part of any hearing conservation programme.	0.78
24. Audiometry and hearing protection are inseparable.	0.74
12. Audiometry and noise control are inseparable.	0.74
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.73
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.70
10. Money spent on audiometry would be better spent on noise control.	-0.68
16. Where a firm has a programme of medical screening audiometry should be part of that programme.	0.66
17. The value of audiometry in industry is unestablished.	-0.64
5. Audiometry is not advisable in an industrial situation.	-0.63
7. Audiometry is an expensive toy for occupational physicians to play with.	-0.60

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Quartimax Rotation

Factor 1 cont'd

ITEM	LOADING
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.56
1. Industrial audiometry is a useful diagnostic tool.	0.55
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.47
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.46
3. Assessing a worker's hearing ability is not necessary in order to protect it.	-0.45
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.44
20. Audiometry is an adjunct to a hearing conservation programme and no more.	-0.44
23. Not enough is known about industrial audiometry to make statements about its usefulness.	-0.42
27. Audiometry is relatively inexpensive.	0.34

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Quartimax Rotation

Factor 1 cont'd

ITEM	LOADING
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	0.31
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.30
21. Audiometry encourages the use of hearing protectors by workers.	0.28
15. Audiometry can never prevent occupational deafness.	-0.25

Quartimax Rotation

Factor 2

ITEM	LOADING
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.74
21. Audiometry encourages the use of hearing protectors by workers.	0.53
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.32

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Quartimax Rotation

Factor 3

ITEM	LOADING
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.60
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.36
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.	0.31
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.31
5. Audiometry is not advisable in an industrial situation.	0.28
10. Money spent on audiometry would be better spent on noise control.	0.27
23. Not enough is known about industrial audiometry to make statements about its usefulness.	0.26

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Quartimax Rotation

Factor 4

ITEM	LOADING
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise-induced hearing-loss.	0.55
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	0.47
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.32
12. Audiometry and noise control are inseparable.	-0.30
10. Money spent on audiometry would be better spent on noise control.	0.30
27. Audiometry is relatively inexpensive.	-0.28

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Equimax Rotation

Factor 1

ITEM	LOADING
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.59
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.	0.56
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.55
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.51
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.48
24. Audiometry and hearing protection are inseparable.	0.42
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.38
12. Audiometry and noise control are inseparable.	0.32

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Equimax Rotation

Factor 2

ITEM	LOADING
22. Audionetry encourages managements to take an interest in the problem of noise at work.	0.82
21. Audiometry encourages the use of hearing protectors by workers.	0.59
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.39
12. Audiometry and noise control are inseparable.	0.37
23. Not enought is known about industrial audiometry to make statements about its usefulness.	-0.33
1. Industrial audiometry is a useful diagnostic tool.	0.29
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.27
5. Audiometry is not advisable in an industrial situation.	-0.26

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Equimax Rotation

Factor 3

ITEM	LOADING
27. Audiometry is relatively inexpensive.	-0.52
5. Audiometry is not advisable in an industrial situation.	0.50
7. Audiometry is an expensive toy for occupational physicians to play with.	0.48
9. Industrial audiometry is basically anti-worker.	0.48
23. Not enough is known about industrial audiometry to make statements about is usefulness.	0.46
17. The value of audiometry in industry is unestablished.	0.32
1. Industrial audiometry is a useful diagnostic tool.	-0.32
2. Audiometry is an essential part of any hearing conservation programme.	-0.26
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.	-0.25

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Equimax Rotation

Factor 4

ITEM	LOADING
12. Audiometry and noise control are inseparable.	0.66
10. Money spent on audiometry would be better spent on noise control.	-0.63
24. Audiometry and hearing protection are inseparable.	0.46
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise-induced hearing-loss.	-0.44
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.37
20. Audiometry is an adjunct to a hearing conservation programme and no more.	-0.34
3. Assessing a worker's hearing ability is not necessary in order to protect it.	-0.30
27. Audiometry is relatively inexpensive.	0.29
2. Audiometry is an essential part of any hearing conservation programme.	0.28
17. The value of audiometry in industry is unestablished.	-0.27

MEDICAL OFFICERS NOT PERFORMING AUDIOMETRY

Equimax Rotation

Factor 4 cont'd

ITEM	LOADING
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.	0.27
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.26

INDUSTRIAL MEDICAL OFFICERS' QUESTIONNAIRE

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

34 RESPONDENTS

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Principal Components Analysis

Factor 1

	ITEM	LOADING
4.	A higher priority should be given to testing the hearing abilities of workers than is given at present.	-0.85
10.	Money spent on audiometry would be better spent on noise control.	0.80
12.	Audiometry and noise control are inseparable.	-0.79
2.	Audiometry is an essential part of any hearing conservation programme.	-0.77
22.	Audiometry encourages managements to take an interest in the problem of noise at work.	-0.75
24.	Audiometry and hearing protection are inseparable.	-0.74
7.	Audiometry is an expensive toy for occupational physicians to play with.	0.74
18.	Audiometric examinations should be used by firms to protect themselves against litigation by workers for alledged noise-induced hearing-loss.	-0.72
21.	Audiometry encourages the use of hearing protectors by workers.	-0.70

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.	-0.69
27. Audiometry is relatively inexpensive.	-0.67
17. The value of audiometry in industry is unestablished.	0.66
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	-0.64
13. Firms should be compelled by law to periodically test the hearing of their employees.	-0.62
5. Audiometry is not advisable in an industrial situation.	0.61
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	-0.57
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	-0.53
1. Industrial audiometry is a useful diagnostic tool.	-0.50
15. Audiometry can never prevent occupational deafness.	0.49

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Principal Components Analysis

Factor 1 cont'd

ITEM	LOADING
23. Not enough is known about industrial audiometry to make statements about its usefulness.	0.46
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	-0.43

Principal Components Analysis

Factor 2

ITEM	LOADING
17. The value of audiometry in industry is unestablished.	-0.57
19. The result of an audiometric examination may be used by a worker as a basis for a claim against his employer for alleged noise-induced hearing-loss.	-0.52
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	-0.49
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Principal Components Analysis

Factor 3

ITEM	LOADING
1. Industrial audiometry is a useful diagnostic tool.	0.50
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	-0.50
19. The result of an audiometric examination may be used by a worker as the basis for claim against his employer for alleged noise-induced hearing-loss.	0.47

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Varimax Rotation

Factor 1

ITEM	LOADING
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.74
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.	0.72
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.68
24. Audiometry and hearing protection are inseparable.	0.66
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.64
21. Audiometry encourages the use of hearing protectors by workers.	0.62
12. Audiometry and noise control are inseparable.	0.61
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.55
27. Audiometry is relatively inexpensive.	0.47

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Varimax Rotation

Factor 2

ITEM	LOADING
1. Industrial audiometry is a useful diagnostic tool.	0.81
9. Industrial audiometry is basically anti-worker.	-0.59
23. Not enough is known about industrial audiometry to make statements about its usefulness.	-0.49
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.47
6. Audiometry has no effect on industrial relations.	-0.44

Varimax Rotation

Factor 3

ITEM	LOADING
17. The value of audiometry in industry is unestablished.	0.69
5. Audiometry is not advisable in an industrial situation.	0.64
3. Assessing a worker's hearing ability is not necessary in order to protect it.	0.55
25. Not many people in industry care very much about audiometry.	0.46

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Varimax Rotation

Factor 4

ITEM	LOADING
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	0.81
2. Audiometry is an essential part of any hearing conservation programme.	0.78
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.57
27. Audiometry is relatively inexpensive.	0.50
10. Money spent on audiometry would be better spent on noise control.	-0.49

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Quartimax Rotation

Factor 1

ITEM	LOADING
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.86
12. Audiometry and noise control are inseparable.	0.82
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.80
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.79
24. Audiometry and hearing protection are inseparable.	0.76
10. Money spent on audiometry would be better spent on noise control.	-0.75
2. Audiometry is an essential part of any hearing conservation programme.	0.74
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.	0.74
21. Audiometry encourages the use of hearing protectors by workers.	0.70

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Quartimax Rotation

Factor 1 cont'd

ITEM	LOADING
27. Audiometry is relatively inexpensive.	0.69
7. Audiometry is an expensive toy for occupational physicians to play with.	-0.62
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	0.62
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.59
5. Audiometry is not advisable in an industrial situation.	-0.58
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.55
17. The value of audiometry in industry is unestablished.	-0.55
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.50
15 Audiometry can never prevent occupational deafness.	-0.50
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.49

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Quartimax Rotation

Factor 1 cont'd

ITEM	LOADING
1. Industrial audiometry is a useful diagnostic tool.	0.44

Quartimax Rotation

Factor 2

ITEM	LOADING
19. The result of an audiometric examination may be used by a worker as the basis for a claim against his employer for alleged noise-induced hearing-loss.	0.85
20. Audiometry is an adjunct to a hearing conservation programme and no more.	0.52
6. Audiometry has no effect on industrial relations.	-0.41

Quartimax Rotation

Factor 3

ITEM	LOADING
1. Industrial audiometry is a useful diagnostic tool.	-0.71
9. Industrial audiometry is basically anti-worker.	0.52
23. Not enough is known about industrial audiometry to make statements about its usefulness.	0.42
6. Audiometry has no effect on industrial relations.	0.37

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Quartimax Rotation

Factor 4

ITEM	LOADING
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	-0.60
11. Audiometric examinations provide a good opportunity for educating workers about the effects of noise on hearing.	0.60
2. Audiometry is an essential part of any hearing conservation programme.	-0.46

Quartimax Rotation

Factor 5

ITEM	LOADING
17. The value of audiometry in industry is unestablished.	0.57
3. Assessing a worker's hearing ability is not necessary in order to protect it.	0.53
5. Audiometry is not advisable in an industrial situation.	0.53
25. Not many people in industry care very much about audiometry.	0.50

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Equimax Rotation

Factor 1

ITEM	LOADING
7. Audiometry is an expensive toy for occupational physicians to play with.	0.96
27. Audiometry is relatively inexpensive.	-0.47
17. The value of audiometry in industry is unestablished.	0.43

Equimax Rotation

Factor 2

ITEM	LOADING
17. The value of audiometry in industry is unestablished.	0.67
5. Audiometry is not advisable in an industrial situation.	0.67
3. Assessing a worker's hearing ability is not necessary in order to protect it.	0.52
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	-0.45
25. Not many people in industry care very much about audiometry.	0.44

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Equimax Rotation

Factor 3

ITEM	LOADING
8. Individuals unfit for employment in noisy areas may be identified by means of audiometry.	0.70
2. Audiometry is an essential part of any hearing conservation programme.	0.67
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.61
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.56
12. Audiometry and noise control are inseparable.	0.53
22. Audiometry encourages managements to take an interest in the problem of noise at work.	0.52
27. Audiometry is relatively inexpensive.	0.50

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Equimax Rotation

Factor 4

ITEM	LOADING
14. Workers regard audiometry as evidence of their employer's concern for their welfare.	0.89
25. Not many people in industry care very much about audiometry.	-0.65
4. A higher priority should be given to testing the hearing abilities of workers than is given at present.	0.42

Equimax Rotation

Factor 5

ITEM	LOADING
1. Industrial audiometry is a useful diagnostic tool.	0.83
9. Industrial audiometry is basically anti-worker.	-0.52
13. Firms should be compelled by law to periodically test the hearing of their employees.	0.49

MEDICAL OFFICERS PERFORMING AUDIOMETRY IN SOME COMPANIES BUT NOT IN OTHERS

Equimax Rotation

Factor 6

ITEM	LOADING
11. Audiometric examinations provide a good opportunity for educating workers about the effect of noise on hearing.	0.77
26. No matter what people say, testing the hearing of workers can't do anyone any harm.	0.64
16. Where a firm has a programme of medical screening, audiometry should be a part of that programme.	0.57
18. Audiometric examinations should be used by firms to protect themselves against litigation by workers for alleged noise-induced hearing-loss.	0.50
24. Audiometry and hearing protection are inseparable.	0.50
21. Audiometry encourages the use of hearing protectors by workers.	0.48

APPENDIX 4:

A LETTER RECEIVED DURING THE SENDING-OUT OF THE INDUSTRIAL MEDICAL OFFICERS QUESTIONNAIRE

APPENDIX 4

This is a letter received by the editor of a journal during the period in which the industrial medical officers' questionnaire had been sent out and returns were arriving. A copy of the letter was sent to RJM for comment. The letter was never actually published but it is included here as an example of the depth of feeling aroused by that part of the research concerned with the attitudes of industrial medical officers towards audiometry.

The identity of the letter's author has been deliberately expunged.

continued....