Chapter II
Historical Resume

In this chapter some of the important studies conducted both in laboratory and field set up to find out the effect of noise on human performance and its psychological and physiological consequences have been reviewed chronologically.

Morgan conducted an experiment (1916) to discover how a person reacts to irrelevant noises. The experiments indicated that at first such noise generally retarded the speed of work, but that this was often followed by an increase in speed. The resulting speed was frequently greater than that achieved prior to the introduction of the irrelevant noises, because the Ss made an extra effort to overcome the effects of noises. In Morgan’s experiment, the Ss exerted greater pressure on the keys and evidenced an increase in articulatory reactions.

Ford (1929) reported that noise, besides interfering with efficiency also constitutes a distraction. He found that not only noise but quiet can also constitute a distraction. It means that an employee who has adjusted himself to a noisy work situation may be distracted by a sudden silence, the quiet that follows the cessation of the noise acts as a distracting influence on performance. This was confirmed both by the objective data and by the
introspective reports of the subjects.

Pollock and Bartlett (1932) in a study found that performance of tasks which demands complete attention is affected by noise as it tends to draw attention away from the task.

Kryter (1950) and Broadbent (1957) did a study to see the effects of predictable and unpredictable noises and observed that tasks requiring long-term attention were more likely to be degraded by noise than tasks requiring short-term attention. The results indicate that more errors occur on a subsidiary task under unpredictable noise conditions than under predictable noise conditions.

In 1960, Broadbent reported that an operator waiting for an inconspicuous event to occur would take longer to respond to it under high-noise conditions. In fact, as the level of noise increases beyond 90 db. and as the length of the working period increases, the vigilance task is affected.

Plutchik (1962) observed, no effect of a high intensity intermittent sound on compensatory tracking and mirror tracing task. He reported that the sound stimulus had no effect on compensatory tracking performance or the total time taken to complete the mirror tracing task though significant increase in invariability of errors in the mirror tracing task occurred.

Broadbent and Gregory (1965) investigated the effect of
variation of signal rate on perception under noisy condition. They found that noise only reduced detections associated with false alarms rates (a risky criterion of report), in tasks with high signal rates. Low signal rate tasks, associated with low levels of false alarms (cautious criterion) were less likely to suffer and showed improvement in detections under noisy conditions.

The effect of noise interference in schools has been observed by many investigators. Wyon (1970) introduced intermittent white noise (55 - 76 dB) on a random schedule, through fully-visible loudspeakers, into secondary school classrooms in Scandinavia. Four classes containing 110 children were observed through one-Way screens, two with noise and two controls. He recorded noticeable change of performance and behaviour, namely, slower reading \( (p < 0.001) \), fewer arithmetical errors \( (p < 0.01) \), less confident and more inconsistent memory \( (p < 0.05) \). He describes waves of 'contagious' fidgeting and inattention after some bursts of noise.

In another study of classroom behaviour Crook and Langdom (1974) looked at five schools (three primary, two secondary) within the 55 NNI contour (that is, the worst aircraft noise environment, in present conditions, near Heathrow). Where teaching took the form of one person (almost always the teacher) speaking to the whole class, interference by aircraft reaching peak noise levels of 70 dBA was such as to impose a pause in the teacher's speech on
an average of two occasions in each 40 minute period. Where teachers were speaking to individuals or small groups, significant interference did not begin until the fly-over peak reached 75 dBA. Where teaching took the form of individual study or group activity, the amount of interference caused by fly-overs was inversely proportional to the existing classroom noise which varied from 55 to 70 dBA. Teachers believed, to a degree that was dose dependent with noise, that the noise was interfering with teaching, was making them more tired at the end of the day and was making them less effective as teachers.

Eschenbrenner (1971) found that intermittent white noise had a detrimental effect on performance of a complex psycho-motor task. It interfered with image motion and compensation performance and the magnitude of the decrement was a function of both the temporal pattern and intensity level of the noise.

In 1976, Purolhit employed a 5x3x2 design to study the effect of auditory noise, pay off and signal probability on visual detection of ten university students. Results indicate that cash down pay-off and different signal presentation probabilities significantly affected the frequency of 'hits' but not of the "false alarms".

Lundberg and Frankenhaeuser (1976) studied the effects of personal control over noise intensity. Thirty male university students performed mental arithmetic under noise
exposure. Every other s was offered a choice between noise intensities, and the next s, serving as his yoked partner, had to submit to the same noise. Mean measures of catecholamine and cortical excretion, heart rate, and subjective effort and discomfort showed that Ss were more aroused in the yoked situation. There were, however, considerable interindividual differences. Ss classified as 'internals' or 'externals' on the basis of scores on Rotter’s Internal-External Locus of Control Scale responded to the 2 experimental conditions in congruence with their general attitudes towards personal control.

The effect of long-term exposure to noise has been studied by Nixon, Johnson and Stephenson (1977). 12 male ss were exposed to continuous pink-noise 185 db, A-weighted for 24 - hr and 48 - hr periods. Hearing threshold levels were obtained intermittently during and following the exposure. The growth and asymptotic level reached in temporary threshold shifts (TTS) under both conditions was essentially the same. However, recovery of hearing (4000 Hz test frequency) took approximately twice as long for the 48 - hr as for the 24 - hr session.

Noise effects are also determined by the sex of the person. In a study by Christie and Glichman (1980) to clarify the relationship between classroom noise and intellectual performance, 156 1st, 3rd and 5th grades worked on a matrix task in either a noisy environment (70 db) or in a quiet environment (40 db). Performance on the
intellectual task increased with age. In the environment with classroom noise, boys consistently solved more complex matrix problems than did girls.

Cohen et al. (1981) studied the cardiovascular and behavioural effects of community noise. Their study revealed that both children and adults can be adversely affected by chronic exposure to noise, that there is a relationship between noise and feelings of helplessness and that task performance is negatively affected by concomitant noise exposure. Findings indicate the need for noise abatement in noisy settings, although short-term protection provided by sound insulation in classrooms may not be sufficient, the effects of noise exposure appear to be long-lasting, and it may take more than 1 year for individual to return to more normal levels of behaviours and health.

Besides laboratory studies, field surveys have also been done to know about the effects of noise. Gambert (1981) conducted a survey to find out about the annoyance caused by road traffic noise. 1279 Antwerp residents were interviewed to examine the relationship between individual annoyance scores and noise levels, and the influence of personality variables, the lay-out of the residence, sensitivity to noise, and demographical variables on this relationship. The lay-out of the home had an important influence on the degree of annoyance caused by traffic noise. Neurosis prone Ss reported greater annoyance from night time traffic noise, and females appeared to be more
susceptible to noise annoyance than were males. However, no clear correlations were found between annoyance scores and demographic data.

de Barbenza (1981) investigated the effects of intense, intermittent and unpredictable noise (80 - 100 db) on 59 Ss (aged 18-49 yrs.) performance on an arithmetic task. Changes in activation level were assessed through measurement of GSR and heart rate; variables such as neuroticism and introversion - extroversion were examined through the Eysenck Personality Questionnaire. The deterioration of performance of Ss judged nonsensitive to noise was related to an increase in activation level; Ss sensitive to noise showed a performance decrement due to factors such as level of neuroticism and noise susceptibility as well as the mastering effect of the noise itself.

Dill et al. (1982) investigated whether some control over the noise might affect the subject's perception of the situation and so the results of the task. These authors hypothesised that certain aspects of the consent form may give Ss the perception of control over the stressor. 92 undergraduates were divided among 4 conditions varying stress and control. Ss signed consent gotmd gotmd brgotr beig subjected to random bursts of noise. Ss were then administered a written question asking whether or not their consent form had included a statement allowing them to discontinue the experimentation at any time. Empirical support was found for the hypothesis. Analysis revealed
that stressed Ss who, were explicitly informed in a consent forms of their freedom to withdraw from the experiment performed significantly better on cognitive tasks than stressed Ss not so informed.

Not only the intensity and type but the content of noise also effects the performance of the Ss. This was proved in a study by Dornic et al. (1982). Information processing efficiency was studied under conditions of loud "physical" (nonverbal) noise and low-intensity "semantic" (verbal) noise; Ss were a total of 30 high school and college students (ages 17-28 yrs). A repetitive task involving a high load on attention and working memory was employed to study adaptation. With short task duration, performance was not differentially affected by the type of noise, but perceived effort was higher in semantic noise than in physical noise. With increasing time on task, there was an adaptation effect for physical noise in terms of both performance and effort.

Another possible factor that could affect the results is whether the testing is being done in the morning or in the evening; the results different in accordance with the level of arousal of the Ss.

Loel, Holding and Barer (1982) decided to investigate this factor. They found that previous work has shown that unpaced mental arithmetic is performed at slower rates in noise, despite unchanged catecholamine indexes of arousal; only male Ss were used, tested early in the day. Since the
times of testing entail arousal effects that interact with noise stress, and the sex of S further modifies these interactions, the present experiment was designed to include these variables. 88 undergraduate were tested on the Noninder Mental Arithmetic task, in quiet or in noise, either in the morning, when arousal was low, or during the early evening, when temperature curves indicate that arousal should be high. Analysis of number of problems attempted show a significant drop for men in noise in the evening; there is no main effect of noise where women's scores are included. Results are compatible with interpretations combining motivation and cognition and indicate the importance of the experimental variables in explaining noise stress effects.

Smith (1983) studied the joint effects of noise and total duration of exposure to noise on recall of order information. He tested the hypothesis suggesting that noise may improve recall of order information in 2 experiments. In experiment I, 19 females watched a television monitor that presented 6 letters in random order during quiet and during noise. Results indicate that the effect of noise on recall of order changed during the course of the task; performance was slightly improved by noise in the first half but impaired by noise in the second. Thus, the usual finding of improvement in recall of order is especially likely to be obtained with short experiments.

In experiment II, 40 females replicated the task of exp. I, with 20 Ss exposed to noise in practice trials and
20 Ss given practice trials in quiet. The purpose of exp. II was to determine whether the later impairment by noise was due to previous exposure to the noise, practice at the task, or both. The results of the 2 experiments show that both noise and practice were necessary to produce the later impairment of order recall.

Antikainen and Pekka (1983) conducted a study to see the effects of neuroticism and the pupillary response to a brief exposure to noise. 16 undergraduates scoring high (neurotics) and low (stables) on the Finnish version of the Eyesenck Personality Inventory Neuroticism and stability scales were exposed individually to 80-100 db A broadband noise. No overt response was made. The dependent variable was pupil dilation. At each level of noise intensity, the dilation was largest immediately after change of intensity. In general the pupil size decreased in the course of the experiment, indicating habituation. Neurotics displayed the largest relative dilation as a function of noise intensity. Results are discussed in terms of the arousing effects of auditory stimulus intensity.

In all the studies quoted above, human beings have been used as Ss. However, the use of human beings in experiments limits the type of recording that can be done since they can not be subjected to any surgery just for the sake of an experiment. Turkkan, Hienz and Harris (1984) used four subadult male baboons in their study. They were implanted with indwelling arterial catheters for continuous
measurement of blood pressure (BP) and heart rate (HR) before, during and after exposure to industrial noise 8 hours daily. Results show that initial exposure to noise produced transient, acute elevations of systolic and diastolic BPs and HRs at noise onset. BPs returned towards baseline after noise exposure was terminated. Plasma catecholamines were also decreased during noise exposure.

Ray, Brady and Emurian (1984) studied cardiovascular effects of noise during complex task performance. Ten human Ss were stimulated with intermittent pink noise during the performance of a computerized task. Each subject received 3 consecutive sessions consisting of 10 minutes of baseline, 30 minutes task performance and 10 minutes of post-task baseline. Noise stimulation was presented during minutes 10-20 of task performance. Task performance was associated with significant increases in mean blood-pressure, heart-rate, and respiration rate and significant decreases in digital pulse amplitude. Noise stimulation was associated with a further decrease in digital pulse amplitude and a further increase in mean blood pressure. Noise and task elicited blood pressure and vasomotor responses did not habituate.

In another experiment, Gawron (1984) studied the effects and after-effects of noise in human performance and affective state in 2 experiments. In experiment I, 48 undergraduate students completed 5 paper-and-pencil performance tests in a noise (85 dBA) and/or quiet (45 dBA)
environment. In experiment II, 24 undergraduates completed 2 mood and 4 environment rating scales under the same conditions as in exp. I. Results indicate reliable noise effects and after-effects on the S's affective ratings but none on their performance.

Li, Cai, Dai, and Guo (1985) studied the memory and concentration of 219 workers exposed to constant noise and 65 control Ss who were kept in a quiet environment. Experimental Ss were exposed to noise as follows: Group I- a steady loud noise (more than 95 dB), Group II- a sudden loud noise (greater than 95 dB), Group III- a steady moderate noise (75-85 dB) and Group IV- a sudden moderate noise (75-85 dB). Each group contained high school graduates and junior high school graduates and elementary school graduates. Scores of all experimental Ss on a memory test were significantly lower than those of control Ss. Test scores of Ss exposed to sudden noise were better than those of Ss exposed to constant noise, but the difference was not significant. Test scores of Ss exposed to moderate noise were superior to those of Ss exposed to loud noise. Higher educational level correlated with higher test scores for all Ss. Similar results were obtained for the attention test, except that performance was determined primarily by Ss' educational level and only secondarily by noise effects.

Edmonds (1985) studied that students' performance varied as a function of sex, noise and intelligence. He randomly assigned 289 6th-grade students to be administered
either the progressive matrices or a reading test. The matrices were assigned to 1 of 8 groups defined by the possible combinations of 2 classroom noise (40 db Vs. 70 db), 2 sex (boys Vs. girls), and 2 intelligence levels (above average Vs. below average) conditions. The same assignment procedure was used for the reading test. Ss in low - noise conditions performed better on the matrices than did the subjects under high noise. For the reading test scores, an interaction between intelligence and level of noise was observed. No evidence for sex differences was found on their test. The results indicate that the effects of intelligence and noise on classroom performance vary as a function of task familiarity.

A very important area of noise research is that of hospital noise since it directly effects the well-being of the patient. Topf (1985) collected data using a 24-item self report measure of disturbance due to hospital noise, from 150 male post operative patient at a VA hospital. Results show that the measure had a reliability of .944. Sensitivity to noise in general was significantly predictive of disturbance due to hospital noise, as was an objective measure of noise (the average amount of running machinery in Ss' room each day). A hierarchical multiple regression showed consistency with these results once variance due to social desirability was accounted for. Findings provide support for the contention that sensitivity to noise and objective noise are predictive of reactions to environments.
In addition, it is suggested that sensitivity to noise is a personal attribute that is predictive of disturbance regardless of the amount of objective noise imposed.

It has been found that the effects of noise are mediated by a constellation of factors whose control is necessary for a realistic evaluation of performance in noise. This idea was reinforced in a study by Gullian and Thomas (1986). They manipulated the cognitive set and followed 36 male and 36 females Ss’ (aged 19-30 years) performances on an arithmetic task under 2 levels of noise. Results show that noise significantly impaired rate of work but had no detrimental effect on accuracy. Noise reduced the pace at which female subjects were working but hardly affected that of male Ss. The differential response patterns of men and women in quiet and noise when working under different cognitive sets resulted in a significant interaction between these factors.

Danenberg, Loos-Cosgrove and Loverde (1987) studied temporary hearing loss and rock music. Pre and post exposure binaural pure-tone air conduction thresholds were obtained for 2000, 4000 and 6000 Hz from twenty 12-17 years old students and adults at a live rock-music concert. 19 students and 6 adults experienced at least a 50 db threshold shift at one or more frequencies, with significant average threshold shifts at all frequencies. 15 students and all the adults who experienced shifts also reported tinnitus. Of the 6 Ss selected to be retested 3 days postexposure, 4
demonstrated only partial recovery to pre-exposure threshold.

In a study by Bhatia and Muhar (1988) the relationship between noise sensitivity and mental efficiency were studied. The modified version of Weinstein's Noise Sensitivity Scale was administered on a large population and a sample of 80 students—40 of high and 40 of low noise sensitivity was drawn. Quantitative output and physiological energy expenditure inferred from the drop of forearm skin resistance, while performing a multiplication task, were measured. Results indicated that due to adaptation, efficiency was not much affected in the case of low noise sensitivity Ss, but adaptation was not effective and efficiency on mental work was adversely affected in the case of high noise sensitivity Ss.

With this historical background, we may now pass on to the next chapter dealing with the problem and hypotheses.