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THE DETERMINATION OF HUMAN STRESS DUE TO NOISE

G.J. McNULTY SHEFFIELD CITY POLYTECHNIC

J. STACEY AMPLIVOX LIMITED

Introduction

In this investigation an attempt has been made to measure the effects of several impulsive noises at various rates of repetition upon the biochemical processes of the body. In other words to examine the degree of psychological stress that the noise imposes upon the body. Separate studies [1,2] stress threshold of each individual and their previous encounters with similar noise induced stress.

In this work the study of brain rhythm activity (EEG) and the galvanic skin response (GSR) has been investigated in relation to subjective induced impulsive noise of a controlled pattern. Some work has been done in which several controlled groups have been exposed to general noise, Orme Johnson [3]. The author shows that repeated exposure to the same noise causes habituation. The onset of habituation is a function of the subject's temperament. To this end in the present investigation every effort was made to ensure that subjects were as relaxed as possible during the tests. Each subject was placed in a relaxed environment and stressed through headphones by a well controlled set of impulsive noises, so arranged as to study the stress reactions for different types of impulse. To date no similar work has been done where the type of impulsive noise has been studied in relation to the subject's reaction. The work will look briefly at the signal stimulus and comment on each type of recording in turn and show where similarities exist so that a behavioural pattern may be suggested as a basis for future study.

The Signals

Two fundamental types of industrial impulsive noise were used as the stimulus. The noises were divided into the following categories:

Category	Examples
Damped Impulse	Drop Hammers
Damped Impulse	Swaging Machines Foundry Casting
Reverberant	Platework and Fabrication Shops

CRO records of these noises are well known [4, 5, 6].

Sensation Level

The intensity of all impulses is controlled throughout the test at a constant level. A subject will respond to a stimulus at its sensation level and not the stimulus intensity level. The Sensation level (dB) = Intensity level - Hearing loss. Thus audiometric tests had to be taken of each subject to establish the sensation level.

Figure 1 shows how the noise stimulus was directed to the subjects. The figure shows that a formal introduction to the test is followed by a section of melodic music which was intended to relax subjects. The impulses follow in a quickening order of repetition. It should also be noted that all the impulses have the same level so that the sensation level will be datumised.

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Alpha Rhythms

An electroencephlogram (EEG) is the graphical result of the electrical activity of the brain. Alpha rhythms are the predominant component of the EEG at about 10 Hz The easiest rhythms to detect are from the crown of the head. The difficulty with these measurements is that the alpha rhythms are inversely affected by an increase in anxiety or stress, and for a very relaxed and unexcitable person even the slightest noise stressor nullifies the alpha rhythm activity. Hence this part of the work met with great difficulty and the predominant feature was initially to obtain a relaxed state. Only about twenty of fifty-three subjects tested showed positive alpha rhythm activity when subjected to the noise stressor.

Galvanic Skin Response (GSR)

The eccrine sweat glands are the most obvious contributions to both skin conductance level and responses. Sweat glands may be viewed as resistors in parallel with each other and with the epidermal pathway. Because the cross sectional areas for each sweat gland are small it is expected that the conductivity of each gland will be small.

The gross changes to a stimulus may be described as follows. At a point about 2 seconds after a brief stimulus for an increase in skin conductance (most easily measured on the palm of the hand) a peak is reached usually in less than a second and may amount to as much as twenty per cent increase in GSR activity. This type of test for stress due to noise stimulus is much easier than EEG as the conductance increases with the stress. Most subjects tested gave a good indication of response compared with EEG tests.

INSTRUMENTATION

Recording Equipment (GSR)

The tape recorder used both to record the Impulsive noise tape and during the tests to play the tape to the subject was a Ferrograph Series Seven. The headphones were to be used for both the noise test and the Audiometry and so a switching box was made, having two inputs, one for the Ferrograph and one for the Audiometer. The Output was connected to the headphones. By this arrangement the audiometry and the noise test could be carried out consecutively without disturbing the headphone placement. A sound level switch was incorporated into the tape recorder within the switch box to enable the sound level to be altered from 50 dB(A) to 90 dB(A) when required. An "artificial ear" coupling was used to connect the headphone earpieces to a sound level meter so that the volume could be adjusted to give an output level of 90 dB(A). The level switch was then used to reduce to 50 dB(A) when required.

Monitoring Equipment

This consisted of a skin resistance meter, the output of which was connected to the input of a tape recorder for results storage and analysis.

Portable Test System. Alpha Rhythm

The Portable Test system was used so that tests were independent of location. This flexibility enabled the tests to be organised in the quietest and most comfortable rooms. The other factor which warranted the Portable Test System was the availability of subjects and variation in times which they could devote to the study.

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The components of the test system are shown schematically in Figure 2, with each component identified.

RESULTS

Figure 3 shows a comparison between the stress levels of the GSR and the EEG. These results have been normalised to each other. There is a reasonable consistency in both methods of recording human stress except for a large scatter at noise stations between 4 and 5 for fast reverberant impulses and rapid non-reverberant impulses. In general the EEG results being difficult to measure are suspect at high levels of stress. Indeed for the stations in question it is surprising that EEG activity existed at all. The signal was so small that it was almost not detectable.

The rapid rise at the incipient stages of the impulses is not surprising and indicates the well known startle effect. The rise is substantially maintained due mainly to the onset of the reverberant impulse of relatively large time intervals. Thereafter despite a very annoying rapid type reverbèration (stations 5-6) the stress level falls even for a faster set of impulses (stations 6-7). The factor which has the greatest influence on the results is the habituation effect.

The correlation of the measured results with the questionnaire is in general poor. The answers to the questionnaire were made for individual noises after each test. Thus the habituation effect is masked in this latter exercise. For example the worst case of annoyance according to the questionnaire is the rapid impact B = 0.15 s, yet it shows the least annoyance effect as the questions were answered after all the noises had been completed.

CONCLUSIONS

The results of human stress to a series of well controlled impacts have been studied. Despite individual uneasiness in the case of certain rapid reverberant impacts which was substantiated with the individual questions the EEG and GSR results showed a low stress level. The main reason for this was that these impacts came at the end of the sequence thus underlying the habituation effect which predominated the results. This brief survey therefore shows that the human stress caused by a wide variety of reverberant noises is soon reduced once the subjects become used to the annoyance.

References

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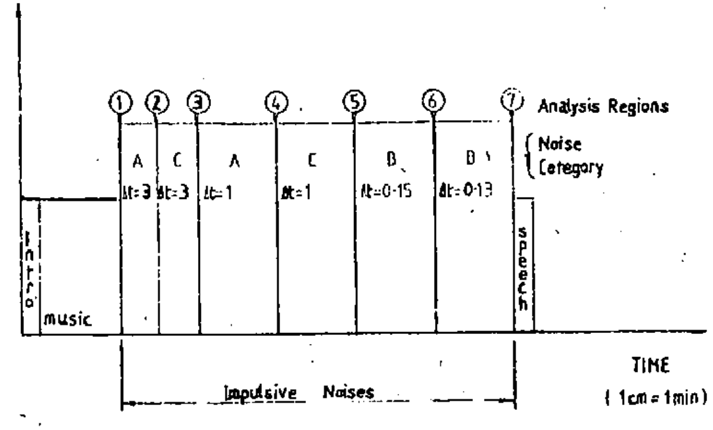
FIGURE 1



All Categories A, B and C are impulsive noises, M = time interval between each in seconds.

A = Non-Reverberant Impulses Drop Hammers -
B = Non-Reverberant Impulses Swaging Machines
C = Reverberant Impulses Fabrication Shop

FIGURE 2

Shows the switchbox arrangement used to switch the headphones between the Noise Tape and the Audiometer.

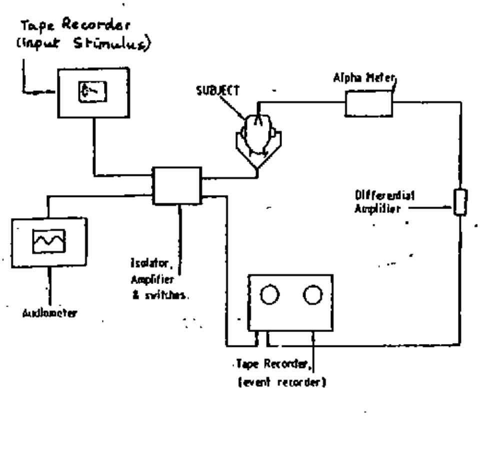


FIGURE 3

Comparison of EEG and GSR for Impact Noises