EFFECT OF NOISE ON REACTION TIME FOR AUDITORY SIGNALS

by

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ABSTRACT

The effect of noise on the time taken to react to pure tone signals was studied. The reaction time was found to increase with rise in the level of noise. Individual differences became more prominent at the higher noise levels. Greater fluctuation in the same individual was also observed with increase in the noise level.

Introduction

The audibility of signals or speech in any listening situation depends to a large extent on the intensity level of the signal or speech in relation to the level of background noise. At low noise levels the signals are heard distinctly, but as the level of noise increases its masking effect on the signal also increases, leading to a stage when the signals can no longer be distinguished from the noise. For the signal to be heard above the noise, its level must be higher than the masked threshold. The masked threshold of a signal depends on a number of factors such as the intensity level and frequency spectrum of the noise, the intensity and frequency of the signal and the duration of the signal[1,2]. Further, in many situations it is not enough if the signals are just heard over the noise. They must be clear enough to be understood or strong enough to be reacted to quickly. Keeping these points in view a simple listening task was taken up for study in this experiment. The aim was to find out the effect of masking on the time taken to detect and respond to pure tone signals.

Experimental Procedure

Method—The task set for the subjects involved listening to pure tone signals mixed with noise of different intensities, and reacting to them quickly by pressing a key. The time taken to initiate the reaction (reaction time) was measured for the same auditory signal in quiet and when partially masked by noises of different levels of intensity.

Each subject was given a number of practice runs before the actual experiment was started. Then four readings of reaction time were obtained from each subject in each case, first without noise and then with a background of broad spectrum noise (0-10kc/s) at five different intensity levels ranging from 70 db to 95 db (overall sound pressure level). The sound signal was a pure tone of 2,000 c/s frequency and 95 db intensity. This frequency was chosen because it falls within the range of maximum sensitivity of the human ear. The intensity level of the signals was fixed at 95 db to allow for sufficient variation in the noise level.

Apparatus—The apparatus used consisted of an audiooscillator (Hewlett-Packard Model 200-C), a noise generator, a mixer, headphones (Brush type BJ) and Chronotron (Electronic Instruments Ltd., England). The noise generator and mixer were constructed in the laboratory. Reaction times were measured with the help of the Chronotron. All the instruments were checked and calibrated before use. A block diagram of the set-up of apparatus is shown in Fig. 1.

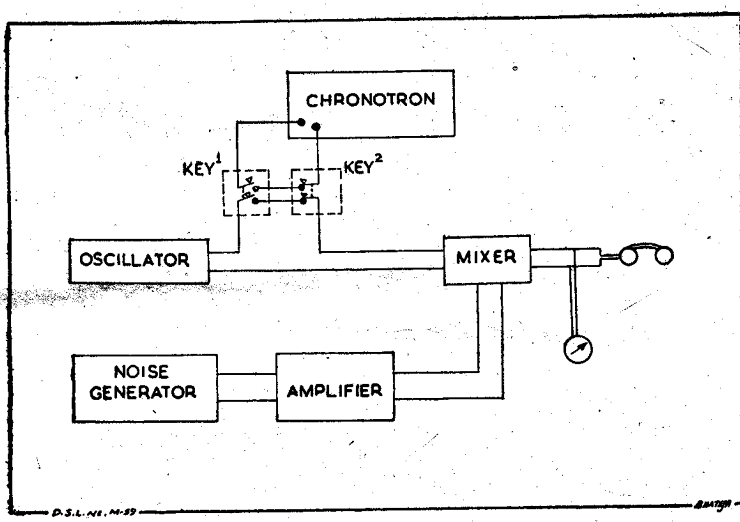


FIG. 1.

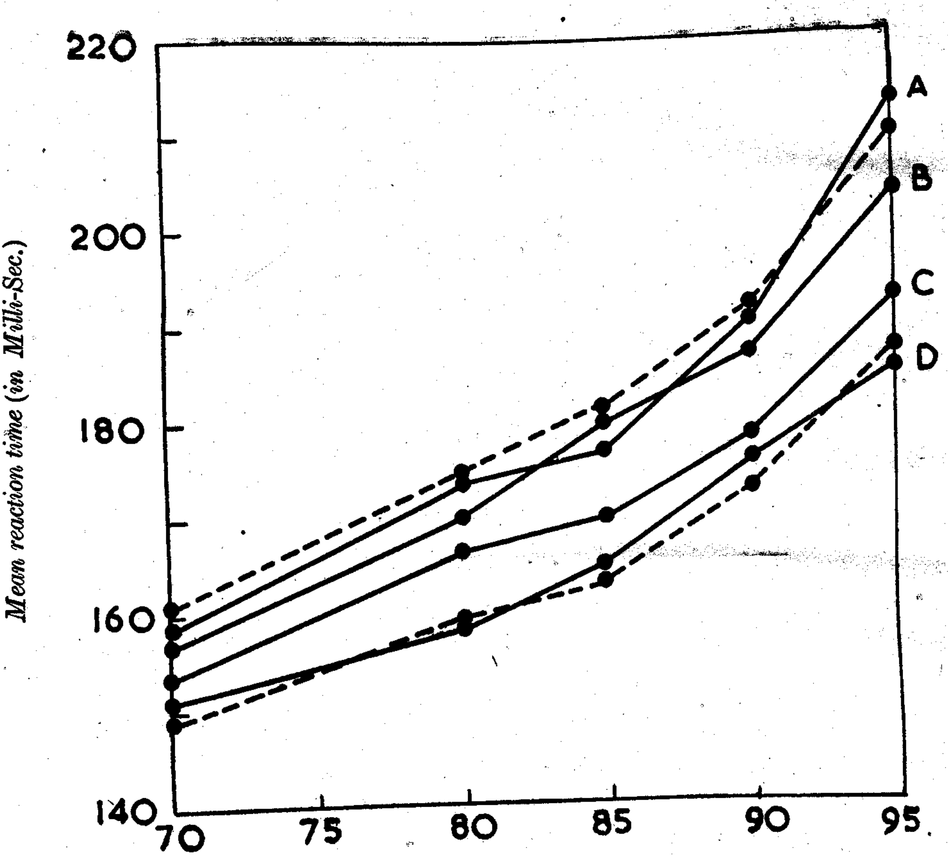
BLOCK DIAGRAM OF THE SET UP APPARATUS

The keys (K_1 and K_2) were of the double pole type and were specially designed for the purpose of this experiment. K_1 when pressed closed two independent circuits and K_2 when pressed opened the same two circuits.

Subjects—Four subjects between 25 to 30 years took part in this experiment. All of them possessed normal hearing ability as judged by a threshold test. They had all taken part in reaction time studies previously. The four subjects chosen formed a homogeneous group. Their reaction times in quiet were of the same order and they gave consistent results on repeated testing. Such a group was chosen because the interest in this experiment centred round changes in reaction time with the level of background noise and not the differences between the subjects.

Results

The mean reaction times of the subjects (A, B, C and D) at different noise levels are plotted in the graphs shown in Fig. 2.



Noise level (in decibels)

FIG. 2

It is evident from the graphs that the mean reaction times of subjects increased with the level of noise. The dotted pair of lines indicates the 95 per cent limits at different noise levels. The mean reaction time values of all the subjects lie within the 95 per cent limits except at the extreme noise level of 95 db. This indicates that the individual differences in reaction times are not significant except at the 95 db noise level.

The average reaction times at different noise levels of all the subjects taken together are shown in Table I.

TABLE I

Average reaction time, standard deviation and standard error at different noise levels

	Noise level (in decibels)				
	70	80	85	90	95
Mean reaction time ..	155·0	167·2	172·3	182·8	198·4
Standard deviation ..	6·65	8·93	10·35	10·82	13·28
Standard error	1·66	2·23	2·59	2·71	3·32

along with their standard deviations and standard errors. The average reaction time shows a steady and significant increase with rise in the noise level. While the reaction time with a noise background of 70 db was only 155·0 milli-seconds (5·5 milliseconds above the value in quiet), it was more than 40 milliseconds higher at 95 db. The standard deviation and standard error obtained here appear to be very much smaller than the values usually expected in reaction time studies. The reasons for this are: the highly selected and practised group of subjects and the controlled nature of the experiment. The standard deviation, however, increased with rise in the level of noise. Analysis has shown that this indicates a significant increase in the within individual variation. That is, the same individual gave more varying results when the interference due to noise was high, than when it was low.

Discussion

It was observed by Wundt[3] very early in the history of experimental psychology that reaction times, both for auditory and visual signals were retarded by noises. In the present experiment a definite delay in reactions was observed at all noise levels and in all the four subjects. It is natural to expect that reactions to auditory signals would be delayed when their clarity goes down as a result of masking, in much the same way as one would expect signals of low intensity to take longer time to evoke responses than those of high intensity[4]. As the noise level goes up, the masking effect of the noise on the signal also increases thus making it more and more difficult to pick up and react to the signal.

The observation that the subjects (A, B, C, and D) differed significantly from each other at 95 db noise level even though at lower noise levels the differences were negligible appears to be interesting. This shows that high level noise background tended to accentuate individual differences. The above finding appears to be supported by the theory that differences in the performance of individuals which are not quite evident in normal conditions show themselves up more markedly under stressful conditions.

The third significant feature is that the within subject variation increased with the noise level. That is the same individual fluctuated to a greater extent when the level of background noise was high (95 db) than when it was low (70 db). This is because the clarity of the signal in the former case was much less than in the latter. It is only to be expected that lack of clarity in a situation brings about instability in performance. The larger within individual differences observed in this experiment may be expected to be a case of this type of instability brought about by lack of clarity in the signal.

Conclusion

Reactions to pure tone signals are delayed when they are masked by noise. The extent of the delay depends on the degree of masking. Differences between individuals are more noticeable at higher noise levels than at lower noise levels. Greater fluctuation in performance is also observed within the same individual with increase in the noise level.

Acknowledgments

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