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# Infrasonic Effects on the Human Organs of Equilibrium

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## Introduction

Human reaction to low frequency acoustic stimulation has been examined in two different intensity ranges. Early work was directed towards the determination of the detection thresholds, but in recent years, interest has developed in the effects of intense pure tone and low frequency noise on man.

From considerations of the frequency response of the static and dynamic labyrinths, it was proposed that tones below 20 Hz could possibly disturb the human balance organs.

Apparatus was therefore developed to deliver intense infrasonic tones and noise with closely controlled acoustic parameters (1). When an adequate ear-seal was achieved sound pressure levels approaching 150 dB could be generated at frequencies down to 1Hz.

## Experimental procedure

Norman electronystagmographic techniques were used to record any vertical or horizontal eye movements, particularly nystagmus, elicited from observers subjected to various levels of infrasound at frequencies in the 0-20 Hz range. Observers were also asked to describe any sensations caused by the infrasound.

The first stage of each test was a five minute period during which the observer sat in a darkened test room while the pattern of eye movements was examined. Any subject who exhibited spontaneous nystagmus with the eyes open, or who was disturbed by the experimental conditions was asked to terminate the experiment at this point. In this way it was found that some 80% of the observers exhibited spontaneous vertical nystagmus with the eyes closed in the absence of any stimulation. However only 2 subjects exhibited spontaneous nystagmus with the eyes open. This is in good agreement with a similar report of Fluur and Eriksson (1961) (2). It was therefore decided that all subsequent work should be performed on observers with open eyes.

When the initial five minute period had been completed a series of low frequency tones was applied, both monaurally and binaurally, over a range of intensities, frequencies and durations. Each subject was exposed to the stimulation only once at each sitting to eliminate the possibility of any overlap effects. Any eye movements elicited were recorded, and the observer was asked for his subjective impressions of the stimulus.

## Results

The most productive of the test conditions used was with the observer sitting, with binaural stimulation, and vertical eye movements measured. 88% of subjects exhibited a clear vertical nystagmus when exposed to sound pressure levels from 130-146 dB at frequencies from 2-10 Hz for 60 secs.

## Nystagmus Threshold

Basically the same experimental techniques were used to measure the threshold for the onset of nystagmus while varying the duration and intensity of the stimulus. Six previously experienced observers were used, each was binaurally stimulated with levels of infrasound ranging from threshold (about 100 dB) to 150 dB, for durations of 5 to 85 seconds. Fig. 1. shows the minimum stimulus necessary to elicit vertical nystagmus at a frequency of 7 Hz. It is evident that this is a function of both the stimulus intensity and duration. Fig. 2 shows that the duration of the nystagmic response is dependent on the duration of the stimulus.

## Discussion

The subjective response reported by a number of observers was one of swaying, which would suggest otolithic stimulation rather than semi-circular canal stimulation. The shape of the nystagmus threshold curve would seem to indicate that for stimulus durations of less than 15 secs some degree of stimulus integration is involved in the production of eye movements. This suggest either a slowly generated fluid flow causing direct stimulation of the otolith system, or that it is not a straight forward stimulation effect but a fatigue or confusion effect.

## References


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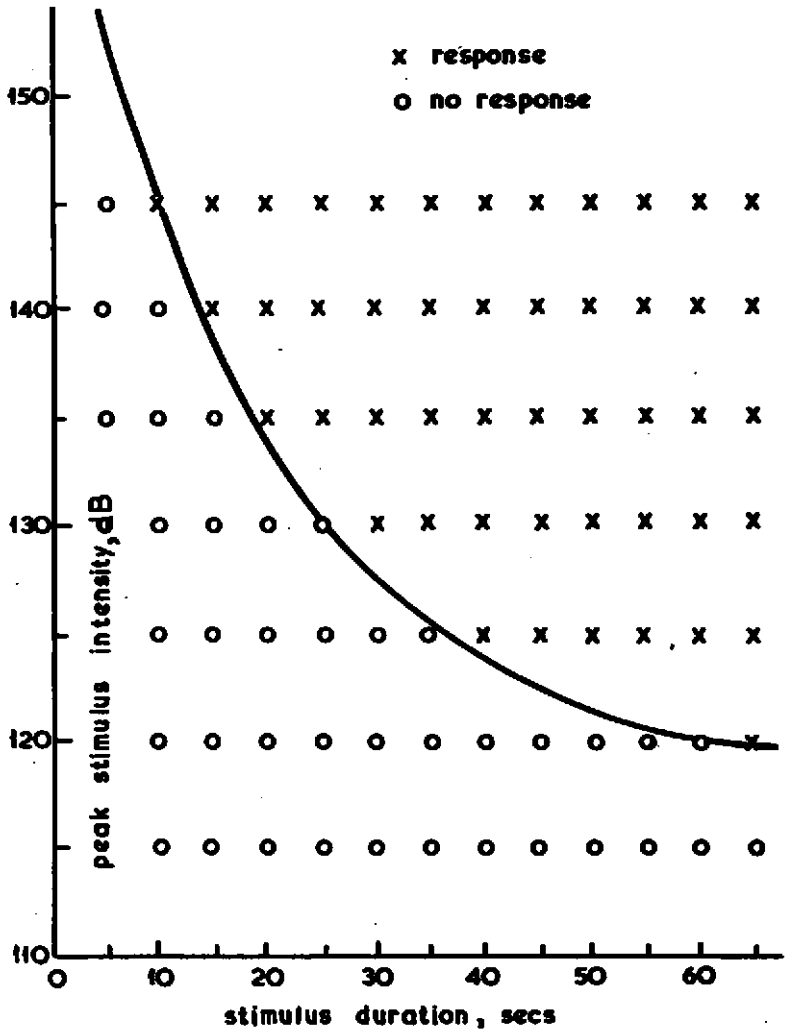
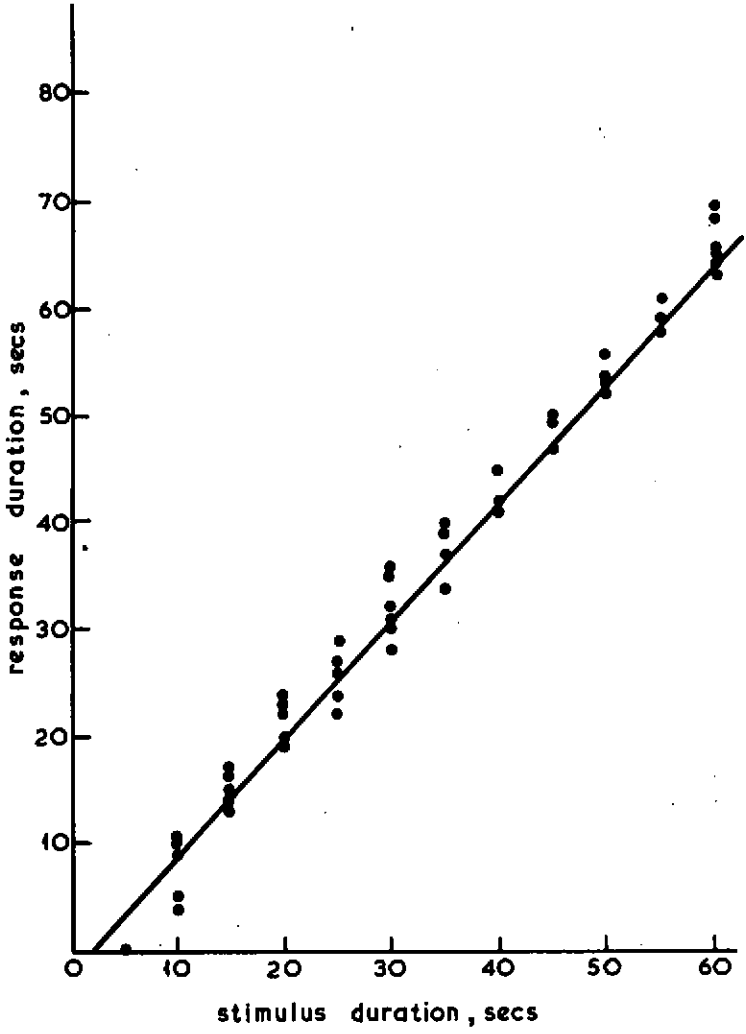



Threshold curve for Vertical Nystagmus induced by a 7Hz Binaural signal.

Fig. 1




Stimulus duration vs. response duration.
6 subjects — frequency 7Hz — SPL 145dB

Fig. 2