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Temporary Threshold Shift (TTS) for FM Tone and Steady Tone

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INTRODUCTION:

The human auditory system is not equipped to handle prolonged exposure to high intensity sounds. For reasons not clearly known sensitivity of hearing declines. Researchers are trying to identify the mechanisms responsible for post stimulatory decline in auditory sensitivity and its subsequent return to pre-exposure level. The understanding of mechanism involved in auditory fatigue will improve our understanding of auditory physiology in normals and pathophysiology in noise induced hearing loss (NIHL). The most common index for auditory fatigue is temporary threshold shift has generated a number of interesting investigations both experimental and clinical and perhaps been the most studied after effect of auditory stimulation.

Although the TTS mechanisms are not very clear, attempts to unravel them has produced a lot of experimental facts about TTS. The primary factors which influence the size of TTS are intensity of fatiguing stimulus, frequency of the fatiguing stimulus, duration of the fatiguing exposure, recovery process and test frequency exposure, recovery process and test frequency. If the stimulus is intermittent, interruption rate and pulse repetition rate are also contributing factors.

Miscellaneous factors that effect TTS are resting threshold (Ward, 1963), interactive effects (Ward, 1961a), latent and residual effects (Ward, 1960a) Harris, 1955), vibration (Morita, 1958; Yokoyama et al. 1974), vitamin A (Ward, 1963); oxygen (Hirsh and Ward, 1952), Salt (Cook, 1952); Iris Pigmentation (Tota and Bocci, 1967; Karlovich, 1975); Drugs (Lehnhardt, 1969; level of consciousness and Central factors (Chernyak, 1968; Babighian, 1975); Binaural and monoaural stimulation (Hirsh, 1958, Shivashanker, 1976), Ear difference (Glorig, and Rogers, 1965; Ward, 1967; Jerger, 1970; Weiler, 1964) etc.,

Various researchers have studied TTS using steady tone (Kryter, 1950; Ward, 1962) high frequency noise (Ward, 1962; Vyasamurthy, et al. 1973), broad-band noise (Kavlowich and Wiley 1974), low frequency noise (Mills and Lilly, 1971; Burdick et al. 1977; Mills et al. 1983), impulsive noise (Loels, and Fletcher, (1968), pop music (Jerger and Jerger, 1970;Wieler et al. 1974; Axelson and Lindgren, 1977; Lindgren and Anelson, 1983); Rock and Roll (Jerger and Jerger, 1970, Lindgren and Axelson, 1983) etc.,

As reported in the literature TTS can be affected by different types of stimulus such as pure tone, narrow band noise, broad band noise, pop music, impulse noise, high frequency noise etc. The frequency modulated (F.M) tone shows a different spectrum as compared to the steady tone.

The sounds which we encounter in everyday life often change in frequency and

amplitude from moment to moment. In the laboratory, the perception of such sounds is often studied using either frequency modulated or amplitude modulated sine waves. Such waves consist of a carrier frequency (a sine wave) upon which same other signal is impressed. In frequency modulation, the carrier's instantaneous frequency is varied in population to the modulating signal's magnitude, but the amplitude remains constant. Pure tone is a sound wave whose instantaneous pressure variation as a function of time, is sinusoidal function. A simple periodic sound is called as a pure tone in common usage.

Kumar and Rangamani (1981) studied TTS2 for pure tone and warble tones. The study was done using 10 subjects to know the effect of warbling on the temporary thereshold shift measured after 2 minutes. The result showed a significant difference between the TTS2 for warble tone and the TTS2 for pure tone. No explanation for this significant difference was given.

Hence the present study was aimed at studying if there is any significant difference between the TTS produced by the FM tone and steady tone. Further it may have theoretical implications in the field of auditory physiology.

METHODOLOGY:

Subjects:

Two subjects in the range of 17 to 23 years, with a median age of 20 years took part m this study. The selection of subjects was done on a random basis and met the following criteria:

1. They should not have any history ear discharge, tinnitus ear ache, headache, giddiness, exposure to loud noise or any other otologic complaints
2. Hearing sensitivity withing 20dB HL (ANSI 1969) at frequencies from 250Hz to 8000Hz at octave intervals.

Instrument used:

The Grason-Stadler Audiometer (GSI-16) with TDH-50P earphones with supra aural cusions was used. The audiometer was calibrated according to the specifications given by ANSI, 1969; ISO: 1975. The audiometer was frequency modulation of ±5% of centre frequency at a rate of 5Hz.

Test environment:

The study was carried out in an acoustically sound treated 2 room situation. The ambient noise level present in the test rooms were below the permissible ISI-1964 maximum allowable noise level.

Procedure:

All the subjects were screened at 20dB HL (ANSI-1969) at frequencies from 250Hz to 8000Hz at octave intervals to find out the presence or absence of a hearing loss in both the ears.

Theresholds were established for the right ear at 4000Hz using Modified Hughson-Westlake procedure with pulsed pure tone and frequency modulated tone separately.

Each subject was tested in two sessions. In the 1st session each subject was exposed to 2KHz pure tone at 110dBHL for 10 minutes TTS2 was determined at test frequency i.e. 4000Hz, one octave higher than the fatiguing frequency IInd session was similar to 1st session, for expect for the fatiguing stimulus. Here each subject was exposed to 2KHz frequency modulated tone at 110dB HL for 10 minutes. A rest period of seven days was given between the two sessions for the complete recovery to occur.

The data obtained was subjected to relevant statistical analysis.

RESULTS:

For each subject TTS_0, TTS, and TTS_2 was calculated for both pure tone and frequency modulated tone. The mean TTS observed for the stady tone stimulus was 35.5dB, 31dB and 27.5dB for TTS_0, TTS1, TTS_2 respectively and 35dB, 30dB and 28dB for the frequency modulated tone for TTS_0, TTS2, TTS_2 respectively (Table-1).

Table-1: Showing mean TTS for steady and FM tone in dB HL at 4KHz (fatiguing stimulus 2KHz).

	TTS0	TTs1	TTS2
Steady tone	35	31	27.5
FM Tone 35	30	28	
T Values 12	18.5	20	

The difference between the means for the steady tone and frequency modulated tone was tested for its significance by using Wilcoxon matched pair sign ranks test.

No significant difference was observed between the TTS_0, TTS1 and TTS_2 at .01 level of significance with a T' value of 12, 18.5 and 20 respectively.

DISCUSSION:

The present study was aimed to study the difference between the TTS produced by steady tone and frequency modulated tone. The results indicate that there is no significant difference in the amount of TTS produced by steady tone and frequency modulated tone.

Kumar and Rangamani (1981) studied TTS2 for pure tone (steady tone) and warble tone (frequency modulated) tone at l00dB SPL with fatiguing frequency of 200Hz and test frequency of 4000Hz. They reported a significant difference in the amount TTS_2 produced by the two stimuli.

However the results of present study is not in agreement with the above study. The controversy still lies that whether there is a difference in the amount of TTS produced by steady tone and warble tone which may be due to the methodological differences between the two studies. The present inves-. tigation studied the TTS at stimulus intensity of 1 l0dB HL whereas the earlier study by Kumar and Rangamani (1981) used the stimulus intensity of l00dB SPL.

To study the amount of TTS produced by steady tone and frequency modulated tone further investigation with different test fatiguing frequency and stimulus intensity should be carried out.