A Study of the Relationship between the Acoustic Reflex Threshold and Temporary Threshold Shift *

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Many studies (Borg, 1968 ; Brasher *et al.*, 1969 ; etc.) have been reported regarding the influence of the acoustic reflex (AR) on temporary threshold shift (TTS). The relation between TTS and AR exists because when reflex occurs there will be an attenuation of low frequency sounds reaching the cochlea. As TTS is related to the intensity of the signal reaching the cochlea, the reduction in the intensity of the signal brought about by reflex action can be expected to result in less TTS. Thus the relation between TTS and AR is reasonable.

There are also many studies (Ward, 1967 ; Harris, 1967 ; etc.) which indicate that the amount of TTS can be a predictor for susceptibility to noise induced hearing loss (NIHL) or permanent threshold shift (PTS). On the basis of TTS, many test have been developed to identity subjects who are susceptible to NIHL or PTS. It is assumed that subjects who exhibit more TTS may be considered to have "tender" ears and that those subjects who exhibit less TTS for the same stimulus may be considered to have "tough" ears.

Studies (Johansson *et al.*, 1967 ; Miyakita *et al.*, 1978) show that there is a relation between the acoustic reflex threshold (ART) and susceptibility to NIHL or PTS. Review of literature on this aspect is scanty. As many investigators have assumed a relation between susceptibility to NIHL and TTS, the question arises whether there is any relation between TTS and ART.

So, the present study was an attempt to study the relationship between the TTS and ART in a normal hearing population with regard to the subject's susceptibility to NIHL or PTS in order to arrive at some conclusions regarding the ART as a possible predictor for susceptibility to NIHL or PTS.

Assuming that there are "tough" and "tender" ears, it may be reasonable to speculate that subjects who show very low reflex thresholds, may be the subjects who have "tender" ears and that the subjects who show high reflex thresholds may be the subjects who have "tough" ears.

Generally, there is what is called biological compensations in all the organisms. Defensive mechanisms, either primitive or specialized, are a part of the living system itself. Starting from the lowly organized

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organisms to normals, there are various defensive mechanisms.

For example, the paramecium, which is a single-celled animal, possess defensive structures called trychocysts. These are sharp needle-like threads which are shot out when the organism is attacked by enemies.

Some fishes like torpedo possess electric organs which are capable of giving a powerful shock of painful intensity to its enemies.

Insect-feeding bats can fly in complete darkness. They are able to avoid small obstacles and locate and track insects by emitting ultrasonic cries to detect the echoes. The time taken for each echo to reach its ears and the direction from which the echo comes, inform the moving bat about the changing range and bearing of the echo signal.

With this view in mind, we can assume that the subjects with "tender" ears have compensatory defensive mechanisms through the acoustic reflex. Probably we can also assume that the subjects with "tender" ears might be receiving protection through the AR, *i.e.*, contraction of muscles might be expected at low levels of intensity and also we can expect greater magnitude of contraction to attenuate the energy of the stimulus reaching the inner ear in order to protect the inner ear from damage.

The present study consisted of two stages:

(*a*) *Stage I* Procedure to measure the acoustic reflex threshold and the magnitude of the reflex for tones presented at 10 dB above the acoustic reflex thresholds at 500 Hz, 1 KHz, 2 KHz and 4 KHz for the right ear.

(*b*) *Stage II* Procedure to measure the temporary threshold shifts at 2 KHz and 4 KHz at the same ear (right ear). The subjects were fatigued by a 1000 Hz tone at 120 dB SPL for 10 minutes continuously. The TTS was determined at 2 KHz after 2 minutes of recovery period (TTS_2). The frequency 2 KHz was selected because it is established that the TTS is more at one octave above the stimulating frequency. Immediately after finding the TTS_2 for 2 KHz, the TTS was established for 4 KHz.

The test–retest reliability was found by using the product-moment coefficient of correlation.

The data collected was then analyzed using appropriate statistical methods. Graphical analysis was given due consideration since it provided a better representation and understanding of this s udy.

The following *conclusions* were made from the study :

(1) There is good relationship between the TTS at 2 KHz (obtained for a stimulating tone of 1000 Hz) and the ART at 1 KHz. Thus the relationship between TTS and ART appears to be frequency dependent. However the frequency dependence regarding the fatiguing stimulus and the stimulus eliciting the acoustic reflex needs further investigations.

(2) Subjects who show greater TTS exhibit low acoustic reflex thresholds and subjects who show less TTS exhibit high acoustic reflex thresholds

(3) There exists a good relation between the TTS at 2 KHz (obtained for a stimula ing tone of 1000 Hz) and the average magnitude of the reflex (at 500 Hz, 1 KHz and 2 KHz) and the magnitude of the reflex at 500 Hz. The TTS at 4 KHz (ob ained for a s imula ing tone of 1000 Hz) and the magnitude of the reflex at 1 KHz also exhibit good relationship.

It can be inferred that subjec s who show greater temporary threshold shifts exhibit greater magnitude of the con rac ion of the acoustic muscles. Thus, there is a relation between the subjects showing greater TTS and magni ude of the reflex. Hence, the magnitude of the reflex can also be used as a predictor for susceptibility to NIHL or PTS other than the TTS.

(4) The average magnitude of the reflex (at 500 Hz, 1 KHz and 2 KHz) is in good relationship with the average ART (a) 500 Hz, 1 KHz and 2 KHz) and the ART at 1 KHz and 2 KHz.

This reveals that there is a relationship between the magni ude of the reflex and the ART. It can be inferred that subjects who show low acoustic reflex thresholds exhibit greater magnitude of the reflex for tones presented at 10 dB above the ART and that subjects who show high acoustic reflex thresholds exhibit less magnitude of the reflex for tones presented at 10 dB above the ART.

(5) There is no significant difference between the male and female groups with regard to the mean TTS at 2 KHz and TTS at 4 KHz.

(6) There is no significant difference between the male and female groups with regard to the acoustic reflex thresholds at different frequencies.

(7) There is no significant difference between the male and female groups with regard to the magni ude of the reflex observed at 10 dB above the ART at different frequencies.

(8) On the whole, the analysis of the data reveals that subjects with "tender" ears who exhibit low acous ic reflex thresholds, show greater temporary threshold shifts and a greater magni ude of the contraction of the acoustic muscles through the acoustic reflex and that subjec s with "tough" ears who exhibit high acous ic reflex thresholds less temporary show threshold shifts and less magnitude of the contraction of the acoustic muscles.

(9) The ART could be used as a possible predictor for susceptibility to NIHL or PTS.

Implications of the Study

(1) The ART and the magnitude of the reflex could be used as possible predictors with regard to the individual's susceptibility to NIHL or PTS.

(2) Since the relationship between the ART and TTS is frequency dependent, an evaluation of the individual's susceptibility to NIHL or PTS need only be limited to these frequencies.

Limitations of the Study

(1) In the present study, a large portion of the sample consists of the student population in the age range of 17 years to 30 years, which may not be the true representative of the universe of normal hearing populations.

(2) The limitations inherent in measures of temporary threshold shift as indices of susceptibility for NIHL are also the limitations of this study.

Recommendations

(1) The relation between the frequency of the TTS producing stimulus and the frequency of the stimulus used to elicit the ART should be established by further investigations.

(2) The criteria for selecting subjects should be based on the acoustic reflex thersholds. It would be worthwhile studying the TTS in subjects who exhibit low acoustic reflex thresholds and in these who exhibit high acoustic reflex thresholds.

(3) As the present study contradicts the study of Johansson *et al.* (1967), further investigations are warranted.

(4) As this study throws light on the relationship between the ART and TTS with regard to the subject's susceptibility to NIHL or PTS, it is hoped that this area would serve to stimulate further research.

(5) It will be worthwhile studying the fatigability of the reflex in subjects with low acoustic reflex thresholds as the acoustic reflex thresholds and fatigability may be the predictors of subject's susceptibility to NIHL or PTS.

(6) It will be worthwhile studying the fatigability of the reflex in subjects with high acoustic reflex thresholds as the acoustic reflex thresholds and fatigability may be the predictors of subject's susceptibility to NIHL or PTS.