



## ORIGINAL ARTICLE

# Auditory Fatigue<sup>☆</sup>



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### KEYWORDS

Auditory fatigue;  
Recruitment;  
Acoustic trauma

### Abstract

*Introduction and objectives:* Given the relevance of possible hearing losses due to sound overloads and the short list of references of objective procedures for their study, we provide a technique that gives precise data about the audiometric profile and recruitment factor.

Our objectives were to determine the peripheral fatigue, through the cochlear microphonic response to sound pressure overload stimuli, as well as to measure recovery time, establishing parameters for differentiation with regard to current psychoacoustic and clinical studies.

*Material and method:* We used specific instruments for the study of cochlear microphonic response, plus a function generator that provided us with stimuli of different intensities and harmonic components. In Wistar rats, we first measured the normal microphonic response and then the effect of auditory fatigue on it.

*Results:* Using a 60 dB pure tone acoustic stimulation, we obtained a microphonic response at 20 dB. We then caused fatigue with 100 dB of the same frequency, reaching a loss of approximately 11 dB after 15 min; after that, the deterioration slowed and did not exceed 15 dB. By means of complex random tone maskers or white noise, no fatigue was caused to the sensory receptors, not even at levels of 100 dB and over an hour of overstimulation.

*Conclusions:* No fatigue was observed in terms of sensory receptors. Deterioration of peripheral perception through intense overstimulation may be due to biochemical changes of desensitisation due to exhaustion. Auditory fatigue in subjective clinical trials presumably affects supracochlear sections. The auditory fatigue tests found are not in line with those obtained subjectively in clinical and psychoacoustic trials.

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**PALABRAS CLAVE**

Fatiga auditiva;  
Reclutamiento;  
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**Fatiga auditiva****Resumen**

*Introducción y objetivos:* Ante posibles pérdidas de audición a causa de sobrecargas sonoras y la escasa referencia de procedimientos objetivos para su estudio, aportamos una técnica que suministra datos precisos sobre el perfil audiométrico y el factor reclutamiento.

El objetivo del estudio es la determinación de la fatiga auditiva temporal a través de la respuesta microfónica coclear ante estímulos de sobrecarga de presión sonora y medida del tiempo de recuperación.

*Material y método:* Instrumentación específica para el estudio de microfónicos cocleares, más un generador que nos proporciona estímulos sonoros de diversa intensidad y componente armónico. Utilizamos ratas Wistar. Medimos la respuesta microfónica normal y después el efecto que sobre ella ha ejercido la aportación de sobrecarga acústica.

*Resultados:* Utilizando un tono puro a 60 dB obtenemos una respuesta microfónica. Fatigando de inmediato con 100 dB en la misma frecuencia, a los 15 min obtenemos una pérdida de 11 dB, a partir de los cuales el deterioro se lentifica y no supera los 15 dB. Mediante sonidos de banda compleja aleatoria o ruido blanco no se produce fatiga ni a niveles de 100 dB durante una hora de sobreestímulo.

*Conclusiones:* No existe fatiga a nivel de los receptores sensoriales. El deterioro de la respuesta mediante intenso sobreestímulo posiblemente se deba a alteraciones bioquímicas de desensibilización por agotamiento.

La fatiga auditiva en pruebas clínicas subjetivas afecta a tramos supracocleares. Las pruebas de fatiga auditiva encontradas no coinciden con las obtenidas subjetivamente en clínica ni en psicoacústica.

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**Introduction and Objectives**

The process of auditory deterioration can be quickened by diverse causes, including acoustic environmental factors.

Specific areas are protected with insulating panels designed for acoustic insulation. Companies with a high level of noise have to take precautions and adopt the laws in force.<sup>1</sup>

In discotheques and similar places, we have found noise levels of 100 dB, with peaks at 115 dB. Likewise, listening to music recorded at high sound levels is damaging.

Human beings can bear a sound level of 60 dB without deterioration for 24 h. At 85 dB the exposure should not go over 4 h; at 95 dB the bearable limit is 1 h; with 100 dB exposure should not exceed 15 min; and at 110 dB it should last no longer than 1 min. These considerations are an approximation to noise tolerance.

Fatigue and trauma<sup>2</sup> are two interconnected states with special differentiation. There is a recovery period between both states that can be total or can leave minimum sequelae that are subjectively undetectable in the short term.

The reduction in the threshold of hearing has been studied using various techniques, almost all of them subjective. Enlistment or recruitment becomes present in neurosensory hypoacusis and especially in subjects predisposed to auditory fatigue.

Several authors have proposed techniques for studying recruitment. Fowler<sup>3</sup> presented his method of binaural balance testing for unilateral hypoacusis.

The Lüscher and Zwislocki<sup>4</sup> test (1949), performed on only one ear, consists in asking the patient to differentiate between the sensation of continuous tone and that of the same tone modulated in amplitude.

A technique that somewhat parallels our study is that of Peyser<sup>5</sup> on post-stimulus fatigue.

According to Metz,<sup>6,7</sup> there is positive recruitment if the stapedial reflex presents at less than 60 dB over the threshold.

The Denes and Nauton test in 1950.<sup>8</sup>

Jerger's<sup>9,10</sup> differential test.

The Theilgaard test, based on the fact that the frequency that is most affected is immediately above that of the traumatic stimulus.

Hinalaf<sup>11</sup> studied auditory fatigue in adolescents based on analysing the oto-emissions related to recruitment.

Habermann, Russi, Larsen and many others have carried out studies on the subject.

In our article we provide data on fatigue and traumatism using an objective procedure, which also allows us to study with simulators and non-cooperative subjects through the complete audiometric tracing, plus the recruitment factor.<sup>12</sup>

**Material and Methods**

The equipment used for the functional study of the outer hair cells is of very restricted diffusion, limited to the academic environment in research and clinical practice. The

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