

RECREATIONAL NOISE EXPOSURE AND HEARING EFFECTS IN ADOLESCENTS: FOURTH YEAR OF A LONG-TERM STUDY

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Serra, Mario R.⁽¹⁾; Blassoni, Ester C.⁽¹⁾; Richter, Utz⁽²⁾; Carignani, Alberto J.⁽³⁾; Joekes, Silvia⁽⁴⁾; Yacci, María R.⁽⁴⁾; Minoldo, Gloria⁽³⁾; Abraham, Silvia⁽³⁾; Franco, Graciela⁽³⁾; Pollet, Amanda R.⁽⁵⁾

—⁽¹⁾Centro de Investigación y Transferencia en Acústica (CINTRA)

Universidad Tecnológica Nacional-Facultad Regional Córdoba

Mtro. M. López esq. Cruz Roja Argentina / 5016 Córdoba / Argentina

Fax: 0054 351 4681823 - E-mail: mserra@scdt.frc.utn.edu.ar

—⁽²⁾Physikalisch-Technische Bundesanstalt (PTB)

Bundesallee 100 / 38116 Braunschweig / Germany

Fax: 0049 531 592 1405 - E-mail: Utz.Richter@ptb.de

—⁽³⁾Instituto Otorrino Fonoaudiológico Córdoba (INOFAC)

Hipólito Irigoyen 175 / 5000 Córdoba / Argentina

—⁽⁴⁾Facultad de Ciencias Económicas-Universidad Nacional de Córdoba

Ciudad Universitaria / 5000 Córdoba / Argentina

—⁽⁵⁾Facultad de Arquitectura, Urbanismo y Diseño-Universidad Nacional de Córdoba

Avda.Vélez Sarsfield 260 / 5000 Córdoba / Argentina

ABSTRACT

Preliminary results of the last year of an interdisciplinary long-term study about recreational noise exposure and auditory behaviour in conventional and extended high frequency ranges, taking into account physical and psychosocial variables and developed applying national and international standards. Two groups of adolescents –males and females- were examined from 14 to 17 years old. The results show: a) changes in the recreational habits and in the noises exposure; b) differences between boys and girls; c) significant hearing threshold shift in a percentage of adolescents, specially in the extended high frequency range, related with recreational noises exposure.

INTRODUCTION

As we have expressed at Inter Noise 2000 & 2001 [1], [2], a high percentage of young people are rejected by hearing loss in the pre-occupational medical examination in Argentina. Most of them are exposed to high level music during their recreational activities [3]. A hearing impairment which is severe enough to affect the ability to obtain and hold an appropriate job can also affect the educational opportunities, being an important variable in the social inclusion and career development, post-secondary education [4]. The literature reveals different opinions about possible injury of the auditory system owing to the exposure to high level music and noise recreational activities [1], [2], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17].

In order to analyse the problem, we have carried out an interdisciplinary long-term study, along four years, with two groups of adolescents –boys and girls-, with the aim to know the changes in the hearing threshold –applying conventional and extended high frequency audiometry- and its relationship with the recreational activities. Sound immission levels during the attendance to discotheques and the use of walkman were measured [17]. The results of the two first years of

the study and the results of the third year were delivered in the Inter Noise 2000 & 2001, respectively. In the fourth year, it was discriminated more accurately the exposure to high level sound sources –musical and not musical-, during the daily activities, through a personal interview. The preliminary results are shown in this paper.

METHOD

As it was detailed in Inter Noise 2000 & 2001, only the main aspects are described.

Subjects: The study began with all the pupils attending the third year of high school level during 1998 of two different schools, one for males, another for females. In the second year of the study, the number of pupils was strongly reduced due to changes in the Study Plan, so, the research followed with the same adolescents who remained in both schools. The number of subjects in the fourth year (2001) was: 63 boys and 45 girls.

Audiometer booths for the hearing study: Two audiometer booths were specially built fulfilling the requirements of ISO 8253-1 (1989) and IRAM 4028-1 (1997) standards with regard to the background noise, one for each school.

Audiometers and earphones: Two Madsen audiometers Orbiter 922, fitted with circumaural earphones Senheiser HDA 200, for conventional and extended high frequency range –one for each school- according to IEC 60645-1, 60645-4 and IRAM 4075 standards. The calibration was checked three times per year in the conventional and extended high frequency (EHF) ranges according to ISO 389-5 and ISO 389-8 standards. The headband force measured of the earphones fulfilled the specifications of ISO/TR 389-5 standard.

Procedure: The audiological study was performed yearly in each school obtaining the threshold of each subject in conventional and in extended high frequency ranges, according to ISO 8253-1 and IRAM 4028-1 (bracketing method). The audiometer attenuator steps for the test signal were of 2 dB. Before each audiometer test, an individual otoscopic examination was carried out and a Hearing State Questionnaire was applied. Each subject was tested yearly by the same audiometrician.

Tests performed in the fourth year for the Psychosocial Study:

a) Recreational Activities Questionnaire (RAQ); b) Scale about Attitude Towards High Level Music (ATHLM); c) Differential Semantic Scales (DSS); d) Personal interview (PI)

Procedure: The RAQ was applied yearly in order to know the recreational activities and the changes along the time. Both types of scales, ATHLM and DSS, were performed in the first and in the last year of the study –14 and 17 years–, in order to know differences of attitude between both ages. The PI was carried out in the last year for getting more information about daily activities in order to discriminate more closely the exposure to musical and not musical sound sources.

Measurements of Real Sound Immission Levels: I) In discotheques, measurements in situ were performed by two ways, using: a) a personal dosimeter; b) a chain of portable instruments for recording the music in situ. Both systems were used to carry out unnoticed measurements in the interior of the discotheques, in order to avoid changes of the real sound environment [17]. II) With walkman, another system was applied for measuring the real sound levels immission in the ear of the adolescents when using their walkman [17].

RESULTS

According to the hearing threshold (HT) in the first year of the study, the adolescents were classified in three groups: Group A with normal-hearing in both frequency ranges; Groups B and C: according to their HT shift at one or more frequencies.

The subjects classified in the first year, remain in the same group till the end of the study. The results of the most significant variables of the Group A in the fourth year of the study –56 boys and 39 girls– are shown in this paper.

Characterisation of Boys and Girls According to their Recreational Activities

Table I: Recreational activities and their categories

Variables	Categories of the Variables	Boys	Girls	Signification
Musical Activities				
Musical instruments Interpretation	No interpretation	76,8 %	89,7 %	p<0.038 **
	Low & mid. sound level inst.	3,6%	7,7 %	
	High sound level instruments	19,6 %	2,6 %	
Musical group Participation	No participation	87,5 %	100,0 %	p<0.022 **
	Participation	12,5 %	0,0 %	
Live concerts attendance	No attendance	41,1 %	61,5 %	Ns
	Low attendance	7,1 %	0,0%	
	Middle attendance	26,8 %	17,9 %	
	High attendance	25,0 %	20,5 %	
Discotheque attendance (DA)	No attendance	1,8 %	2,6 %	Ns
	Low attendance	1,8 %	2,6 %	
	Middle attendance	26,8 %	41,0 %	
	High attendance	69,6 %	53,8 %	
Walkman use	No use	53,6 %	56,4 %	Ns
	Low use	12,5 %	7,7 %	
	Middle use	23,2 %	20,5 %	
	High use	10,7 %	15,4 %	
Music exposure (ME)	Low exposure	3,6 %	0,00 %	Ns
	Middle exposure	53,6 %	51,3 %	
	High exposure	42,8 %	48,7 %	
Ears' effects after disco Attendance	No effects	32,1 %	48,7 %	Ns
	Low level of effects	8,9 %	7,7 %	
	Middle level of effects	30,4 %	33,3 %	
	High level of effects	28,6 %	10,3 %	
Ears' effects after walkman use	No effects	96,4 %	100,0 %	Ns
	Effects	3,6 %	0,0%	
Hearing recovery after musical exposure	No – sometimes	16,1 %	2,6 %	p<0.033 **
	Yes	83,9 %	97,4 %	
Not Musical Activities				
Noisy sports practice	No practice	80,4 %	100,0 %	p<0.003 ***
	Practice	19,6 %	0,0 %	
Noisy activities participation (NAP) (during the last two years)	No participation	35,7 %	61,5 %	p<0.019 **
	Low participation	28,6 %	17,9 %	
	Middle participation	21,4 %	20,5 %	
	High participation	14,3 %	0,0 %	
Ears' effects after noisy activities	No effects	75,0 %	87,1 %	p<0.069 **
	Seldom	7,1 %	10,3 %	
	Frequently	17,9 %	2,6 %	
Hearing recovery after noisy activities	No – sometimes	14,3 %	10,3 %	Ns
	Yes	85,7 %	89,7 %	

Reference: *** p = 0.000 — p < 0.010 ** p > 0.010 — p < 0.100

I - In general, "Music Exposure" (ME) is the preferred recreational activity by the adolescents of both groups and "Discotheques Attendance" (DA) the most important variable in relation to ME. In the boy's group, ME and DA have been significantly increased from the first to the fourth year of study [2]. In the girl's group, both variables have not been significantly increased in the third year of study [2], but they have been increased in the fourth year.

II – "Noise Activities Participation" (NAP) -not musical- is lower than ME, in both groups. At the same time, a higher percentage of boys than the girls has been more exposed to NAP during the last two years of the study.

HT Comparison Between Boys and Girls

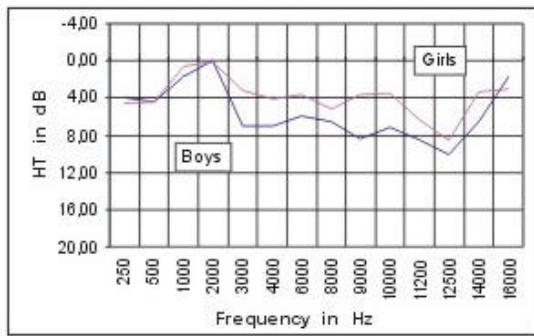


Figure 1a - Right ear: (3000 & 9000) Hz*** (4000, 6000 & 10000) Hz**

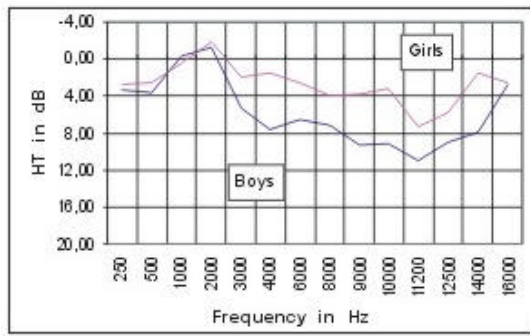


Figure 1b - Left ear: (3000, 4000, 6000, 9000, 10000 & 14000) Hz*** (8000, 11200 & 12500) Hz**

HT in the Two Last Years of the Study

Boys: Because during the third year of the study, an important HT shift in the range of high frequency —more than 30 dB in some cases— was found in a number of boys, not observed in the second year, the whole group was divided in two subgroups [2]. In the fourth year, these subgroups are composed as follow:

- Subgroup 1: with HT no more than 20 dB in all the frequency range: 35 adolescents, equivalent to the 62,5 % of the whole group
- Subgroup 2: with HT more than 20 dB in one or more frequencies: 21 adolescents, equivalent to the 37,5 % of the whole group. See Figure 2.

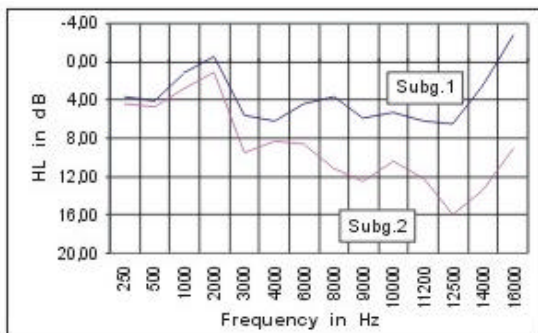


Figure 2a - Right ear: (3000 & 8000 to 16000) Hz*** (6000) Hz**

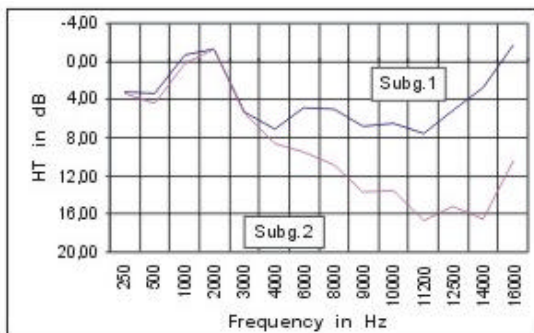


Figure 2b - Left ear: (8000 to 16000) Hz*** (6000) Hz**

Girls: An important HT shift was found in a number of girls in the fourth year of the study. They were also classified, according to the HT above mentioned, in two subgroups as follow:

- Subgroup 1: 26 adolescents, equivalent to the 66,6 % of the whole group.
- Subgroup 2: 13 adolescents, equivalent to the 33,4 % of the whole group. See Figure 3.

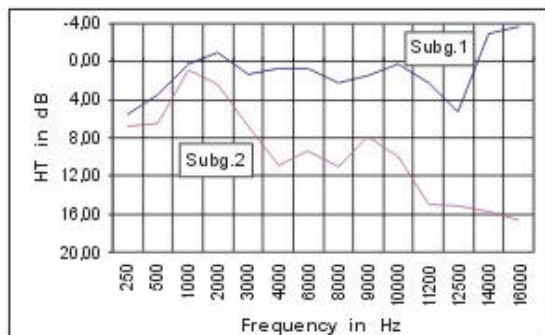


Figure 3a - Right ear: (3000 to 16000) Hz*** (250, 500 & 2000) Hz**

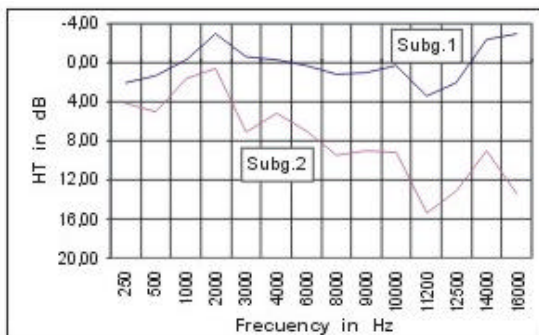


Figure 3b - Left ear: (3000 to 16000) Hz*** (500, 1000 & 2000) Hz**

Characterisation of the Subgroups, by Sex, According to their Recreational Activities

Table II: The significant variables for the characterisation of the subgroups

Variables	Categories	Boys			Girls		
		Subg. 1	Subg. 2	Signification	Subg. 1	Subg. 2	Signification
Live concerts attendance	No	48,6 %	28,6 %	p<0.069 **	65,4 %	53,8 %	Ns
	Low	11,4 %	0,0 %		0,0 %	0,0 %	
	Middle	17,1 %	42,8 %		15,4 %	23,1 %	
	High	22,9 %	28,6 %		19,2 %	23,1 %	
Discotheques attendance	No	2,9 %	0,0 %	Ns	3,8 %	0,0 %	p<0.009 ***
	Low	2,9 %	0,0 %		3,8 %	0,0 %	
	Middle	34,2 %	14,3 %		57,7 %	7,7 %	
	High	60,0 %	85,7 %		34,6 %	92,3 %	
Music Exposure	Low	5,7 %	0,0 %	p<0.000 ***	0,0 %	0,0 %	p<0.000 ***
	Middle	82,9 %	4,8 %		76,9 %	0,0 %	
	High	11,4 %	95,2 %		23,1 %	100,0 %	
Hear.recov.. aft.mus.exp	No-som.	8,6 %	28,6 %	p<0.049 **	0,0 %	7,7 %	Ns
	Yes	91,4 %	71,4 %		100,0 %	92,3 %	
Noisy activities participat.	No	40,0 %	28,6 %	p<0.001 ***	84,6 %	15,4 %	p<0.000 ***
	Low	37,1 %	14,3 %		15,4 %	23,1 %	
	Middle	22,9 %	19,0 %		0,0 %	61,5 %	
	High	0,0 %	38,1 %		0,0 %	0,0 %	
Ears' effec. after noisy activities	No	85,7 %	57,1 %	p<0.045 **	96,2 %	69,2 %	p<0.054 **
	Seldom	5,7 %	9,5 %		3,8 %	23,1 %	
	Frequent	8,6 %	33,3 %		0,0 %	7,7 %	
Hear.recov.. aft.nois.act.	No-Som.	5,7 %	28,6 %	p<0.018 **	0,0 %	30,8 %	p<0.003 ***
	Yes	94,3 %	71,4 %		100,0 %	69,2 %	

Reference: *** p = 0.000 — p < 0.010 ** p > 0.010 — p < 0.100

CONCLUSIONS

The preliminary results of the fourth year of our study let us to say that:

I – According to the Recreational Activity Questionnaire and the Personal Interview, both groups —boys and girls— have increased the exposure to noisy recreational activities along the four years of the study. In the last year there are no significant differences between both groups with regard to their participation in the principal musical activities —discotheque attendance, walkman use, live concert attendance—. But the boy's group has a higher activity in regard with playing musical instruments and at the same time, higher participation in noisy activities not related with music (Table I). So, in general, the boy's group would be more exposed than the girl's group to noisy recreational activities. As consequence, it is important to take into account the exposure of young people to all noisy recreational activity —musical and not musical—.

II — According the HT measured in the fourth year of the study, the HT of the boy's group is higher than the HT of the girl's group (Fig. 1). In both groups, the HT of the left ear tends to be higher than the right ear.

III — In the boy's group as well as in the girl's group there are a percentage of adolescents with a higher HT shift —Subgroups 2— than the rest (Figures 2 & 3). In the case of the boys, the adolescents classified in the Subgroup 2 in the third year of the study remain in it during the fourth year and with a tendency to increase their HT, result that would confirm their permanent hearing threshold shift. In the case of the girls, an smaller percentage was classified in the Subgroup 2 in the fourth year, but their HT shift is similar to the boys.

We have not found any disease in the adolescents of Subgroup 2 which could explain their HT shifts. Throughout the Personal Interview we can affirm that all the adolescents of this Subgroup —boys and girls— have a high exposure to noisy recreational activities —musical and not musical— but not to special dangerous impulse noises.

IV — A percentage of adolescents of the Subgroup 1 has also high exposure to noisy activities (Table I & II). Nevertheless, their HTs remain in all the frequencies below of 20 dB, which is the boundary between both subgroups. It suggests that the individual hearing sensibility would be an important variable to be taken into account.

V — Comparing the mean HT of both sex in the Subgroup 1, the HT of the boys is higher than the HT of the girls. The HT shifts more important are observed in the extended high frequency range for both sex.

As a final discussion, we want to point out two aspects. (1) A high percentage of adolescents are exposed to noisy activities; some of them with small HT shift and others with important HT shift. What is priority: exposure to noisy leisure activities or hearing sensibility? (2) The HT shift observed in the extended high frequency range can be a good predictor of hearing impairment induced by noise in the conventional frequency range.

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