PREVALENCE OF SPONTANEOUS OTO-ACOUSTIC EMISSIONS AND THEIR EFFECT ON TRANSIENT EVOKED OTO-ACOUSTIC EMISSIONS

Reg No. M 9923

Independent Project as a part fulfilment of first year M.Sc, (Speech & Hearing), submitted to the University of Mysore, Mysore.

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MAY 2000

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वागर्थाविव संपृक्तौ, वागर्थप्रतिपत्तये ।
जगतः पितरौ वन्दे पार्वतीपरमेश्वरौ ॥

CERTIFICATE

This is to Certify that this Independent Project entitled ***"PREVALENCE OF SPONTANEOUS OTO-ACOUSTIC EMISSIONS AND THEIR EFFECT ON TRANSIENT EVOKED OTO-ACOUSTIC EMISSIONS"*** is the bonafide work in part fulfilment for the degree of Master of Science (Speech & Hearing) of the student with Register No. M 9923.

Mysore
May, 2000

Director
All India Institute of Speech & Hearing
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CERTIFICATE

This is to Certify that this Independent Project entitled ***"PREVALENCE OF SPONTANEOUS OTO-ACOUSTIC EMISSIONS AND THEIR EFFECT ON TRANSIENT EVOKED OTO-ACOUSTIC EMISSIONS"*** has been prepared under my supervision and guidance.

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DECLARATION

This Independent Project entitled ***"PREVALENCE OF SPONTANEOUS OTO-ACOUSTIC EMISSIONS AND THEIR EFFECT ON TRANSIENT EVOKED OTO-ACOUSTIC EMISSIONS"*** is the result of my own study under the guidance of **Mrs. *P.Manjula,*** Lecturer in Audiology, All India Institute of Speech & Hearing, Mysore and has not been submitted earlier at any University for any other diploma or degree.

Mysore
May, 2000 Reg. No. M 9923

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INTRODUCTION

I. INTRODUCTION

OAEs are acoustic emissions that are produced in the inner ear and are measured with a low-noise microphone placed in the ear canal. OAEs can be evoked by various stimuli (EOAEs) in normal hearing individuals and occur spontaneously (SOAEs) in some normally hearing population.

Both SOAEs and EOAEs are thought to be produced by an active biochemical process in the cochlea. OAEs are generated when the organ of Corti is in near normal condition. The cochlea drives the eardrum into motion through the middle ear osscular chain thus creating OAEs. The sounds generated by the cochlea are small, but potentially audible, sometimes amounting to as much as 30 dB SPL. The instrument recording OAEs consists of an acoustic ear canal probe assembly containing a loudspeaker to stimulate the ear, a microphone to record all the sounds in the ear canal, and a signal separating process that discriminates OAEs and other sounds such as noise and the stimulus. Recording of OAEs does not need any electrodes.

Detection of SOAEs, as sustained acoustic signals, is mainly based on the identification of their spectral content and on short and middle-term reproducibility. The overall findings of the studies

conducted on the prevalence of SOAEs in normal hearing population indicate that SOAEs can be detected in about one-third of the ears of normal hearing individuals. Also, SOAEs are known to be influenced by variables such as age, gender and ear preferences. SOAEs occur with the same prevalence in neonates, children and young adults, (Burns, et al. 1992; Bonfils, et al. 1992; Kok, et al. 1993; Strick-land, et al. 1985). For subjects over 60 years of age, the prevalence of SOAEs appeared to decrease, even when hearing loss remained within normal limits (Bonfils, et al. 1993).

It has been noted that SOAEs are more often observed in the right ears than in left ears and also, twice as many women as men exhibit SOAEs, (Bilger et al. 1990; Penner et al. 1993; Strick land et al. 1985).

Also, the SOAEs are known to influence some properties of EOAEs (Kemp, 1979; Wit, et al. 1981; Zwicker and Schloth, 1984). There are studies that report significant difference in the TEOAE amplitude in the presence or absence of SOAEs (Osterhammel et al. 1996; Gobsch and Tietze, 1993; Probst et al. 1986).

Osterhammel et al. (1996) analysed whether the presence of SOAEs in a group of normal-hearing adults is related to larger TEOAE amplitudes when compared to a similar adult population

without SOAEs. Twenty-four normalhearing subjects age ranging from 15 to 53 years particiapted in the investigation. They were selected to form two groups of twelve each, one containing only subjects with measurable spontaneous emissions, the other of members who had no measurable spontaneous emissions. Each group comprised 7 males and 5 females. TEOAEs were recorded in both linear and non-linear mode, and equivalent sound pressure levels in different octave frequency bands were calculated. For each frequency band, the comparison of the equivalent sound pressure levels in the two selected groups showed statistically significant differences.

In the study by Probst et al. (1986), evoked and spontaneous otoacoustic emissions were recorded bilaterally in a group of normal hearing subjects (n=14, 7 males & 7 females, age ranging from 19 to 35 years with a mean age of 26.2 years). In 12 out of 23 ears, at the frequencies of spontaneous emissions, prominent peaks in both click and toneburst evoked emission spectra were always present.

Bonfils et al. (1992) conducted a study to know the effects of the presence of SOAEs on the EOAE amplitude in a group of pre term neonates (N = 134 ears). Results indicated that EOAE amplitude were most influenced by two main factors: (a) the presence of SOAE and

(b) the Fast Fourier transform (FFT) spectrum, especially the lower limit of the spectrum.

Thus, the present study was carried out to :

1. Study the prevalence of SOAEs in normal hearing population.
2. Find the ear preference for the presence of SOAEs.
3. Find the gender effect on the presence of SOAE.
4. Find the effect of presence of SOAEs on the TEOAE amplitude.

REVIEW OF LITERA TURE

II. REVIEW OF LITERATURE

(A) Prevalence of SOAEs :

Since 1981, many studies have been conducted involving surveys of SOAEs in various human populations. The overall findings of these studies indicate that SOAEs can be detected in about one-third of the ears of normally hearing individuals. The variation in results of Fritze (1983 a, b), who detected SOAEs in 19% of 37 ears, and Cianfrone and Mattia (1986), who recorded SOAEs in 26% of 104 ears, may be attributed to the use of open-microphone systems that were not coupled to the ear canal. Kemp et al. (1979) have shown mat such open-field systems have different acoustical properties that compromise their sensitivity implying that the results of such studies are not comparable to those conducted with closed-sound systems.

It seems reasonable to assume that the incidence of SOAEs may depend on the sensitivity of the recording system, especially for measuring systems with noise floors above 0 dB SPL. However, it is noteworthy that Schloth (1983), using an extremely sensitive system, detected a percentage of SOAEs that was similar to that measured by other investigators such as Zurek (1981), Bright and Glattke (1986) and Wier, et al. (1984), all of whom used much less sensitive equipment. The assumption that SOAE occurrence is dependent on

the noise floor of the measuring instrumentation appears to be valid. This realisation suggests that the true incidence of SOAEs will increase as technological advances reduce the noise of the equipment used to measure emissions. In these principal survey studies listed above over 1000 ears were examined with 34% of them exhibiting SOAEs. SOAEs were recorded in 43% of normally hearing humans. In addition, 13% of all the ears, or 38% of the ears with SOAEs, demonstrated more than one SOAE per ear. Thus multiple SOAEs from a single ear are not uncommon, and upto 10 or more SOAEs can be detected within the same ears (Schloth, 1983; Bright and Glattke, 1986).

In general, it is safe to conclude that about one-third of normal human cochleae, or almost one-half of normally hearing subjects, generate spontaneous oscillations with sufficient amplitudes to be detected as sounds in the external ear canal. Also, SOAEs are known to be influenced by variables such as age, gender and ear preferences. SOAEs occur with the same prevalence in neonates, children and young adults, (Burns, et al. 1992; Bonfils, et al. 1992; Kok, et al. 1993; Strickland, et al. 1985). For subjects over 60 years of age, the prevalence of SOAEs appeared to decrease, even when hearing loss remained within normal limits (Bonfils, et al. 1993).

It has been noted that SOAEs are more often observed in the right ears than in left ears and also, twice as many women as men exhibit SOAEs. (Bilger, et al. 1990; Penner, et al. 1993; Strickland, et al. 1985).

(B) Effect of SOAEs on TEOAE :

SOAEs have influence on the amplitude of TEOAEs (Osterhammel, et al. 1996; Gobsch and Tietze, 1993; Probst, et al. 1986). TEOAE amplitude are influenced by the presence of SOAEs.

Osterhammel et al. (1996) analysed whether the presence of SOAEs in a group of normal hearing adults is related to larger TEOAE amplitudes when compared to a similar adult population without SOAEs. Twenty-four normal-hearing subjects age ranging from 15 to 53 years particiapted in the investigation. They were selected to form two groups of twelve, one containing only subjects with measurable spontaneous emissions, the other of members who had no measurable spontaneous emissions. Each group comprised 7 males and 5 females. TEOAEs were recorded in both linear and non-linear mode, and equivalent sound pressure levels in different octave frequency bands were calculated. For each frequency band, the

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METHODOLOGY

III. METHODOLOGY

A) Subjects:

Thirty-five normal hearing adults (19 males & 16 females) age ranging from 18 to 25 years served as subjects for the measurement of SOAEs. TEOAEs were measured for thirteen of these thirty-five subjects. All these subjects had hearing thresholds within 15 dBHL at the frequencies 250, 500, Ik, 2k, 4k and 8 k Hz served as subjects. The subjects were divided into two groups, one comprising of only subjects with SOAEs and the other without SOAEs. For the measurement of TEOAEs, thirteen (23 ears) of these thirty-five subjects were included. The normal middle ear functioning was confirmed through impedance evaluation.

B) Test Environment:

Test was carried out in a relatively quiet single room situation.

C) Instrumentation:

Madsen Celesta - 503 (version 3.0) was used to detect the SOAEs. The frequency range in the instrument was from 0 - 10000 Hz. The ILO 292 OAE System DP-ECHOPORT (version 5) was used to record the TEOAE data.

D) Procedure for recording SOAE and TEOAE :

Patient Preparation:

The following examinations were carried out on all the thirty-five subjects prior to testing for otoacoustic emissions.

i) Visual insepction:

Visual (otoscopic) inspection of the external auditory canal was done to determine the presence of cerumen accumulation which might preclude signal delivery or response acquisition. No such accumulation was found in these subjects.

ii) **Probe fit:**

Suitable sized ear tip on the end of the probe was inserted into the subject's ear forming an airtight seal with the canal wall. The Probe Fit check started automatically with the presentation of bursts of 10 clicks in the ear canal. It measured the response and then showed the response on the screen. The probe was adjusted in the ear canal until the curve in the Stimulus Response window was as flat as possible (Fig. 1 and 2).

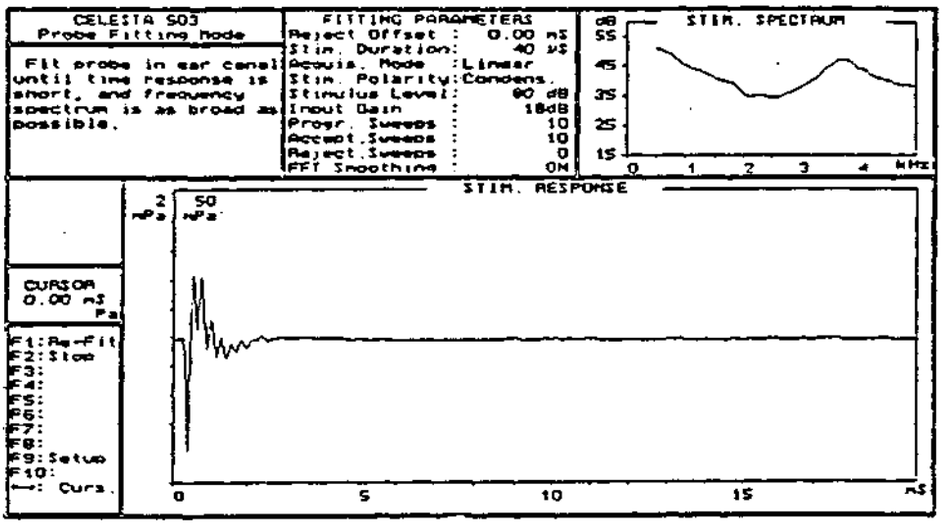
SOAEs were measured in seventy ears from thirty-five subjects and TEOAEs were measured in twenty-three ears of thirteen subjects. Of these twenty-three ears, eight ears had SOAEs and fifteen ears had no SOAEs. The test protocol used for SOAE and TEOAE measurement is as follows:

i) **Protocol for** SOAE **measurement:**

Accepted sweeps = 500

Rejection **percentage** = < **10**

Signal to Noise **Ratio = 6 dB**



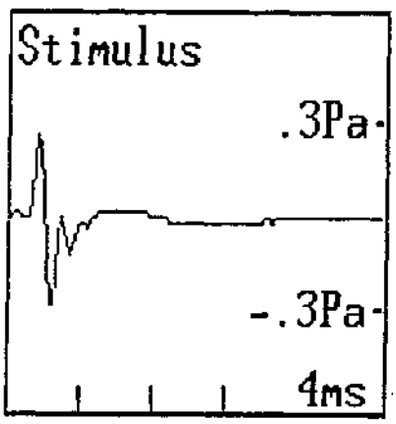


Figure.1 Ac nse for SOAE.

Figure.2 Acceptable probe fit response for TEOAE.

ii) **Protocol for TEOAE measurement:**

Stimulus type = Clicks

Stimulus = 85 dB peak SPL

Reproducibility = > 85 %

Signal to Noise Ratio = 6 dB

For each patient the SOAE and TEOAE were recorded. Those OAEs with a signal to noise ratio of atleast 6 dB were tabulated. Figure 3 and Figure 4 shows the typical SOAEs and TEOAEs amplitude recorded. The values of SOAE and TEOAE amplitudes were tabulated and statistically analysed.

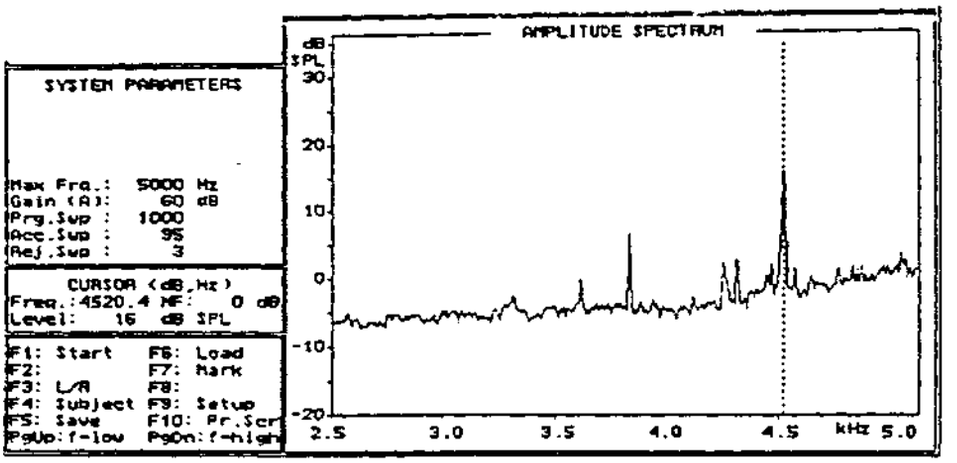


Figure.3 Typical SOAE amplitude.

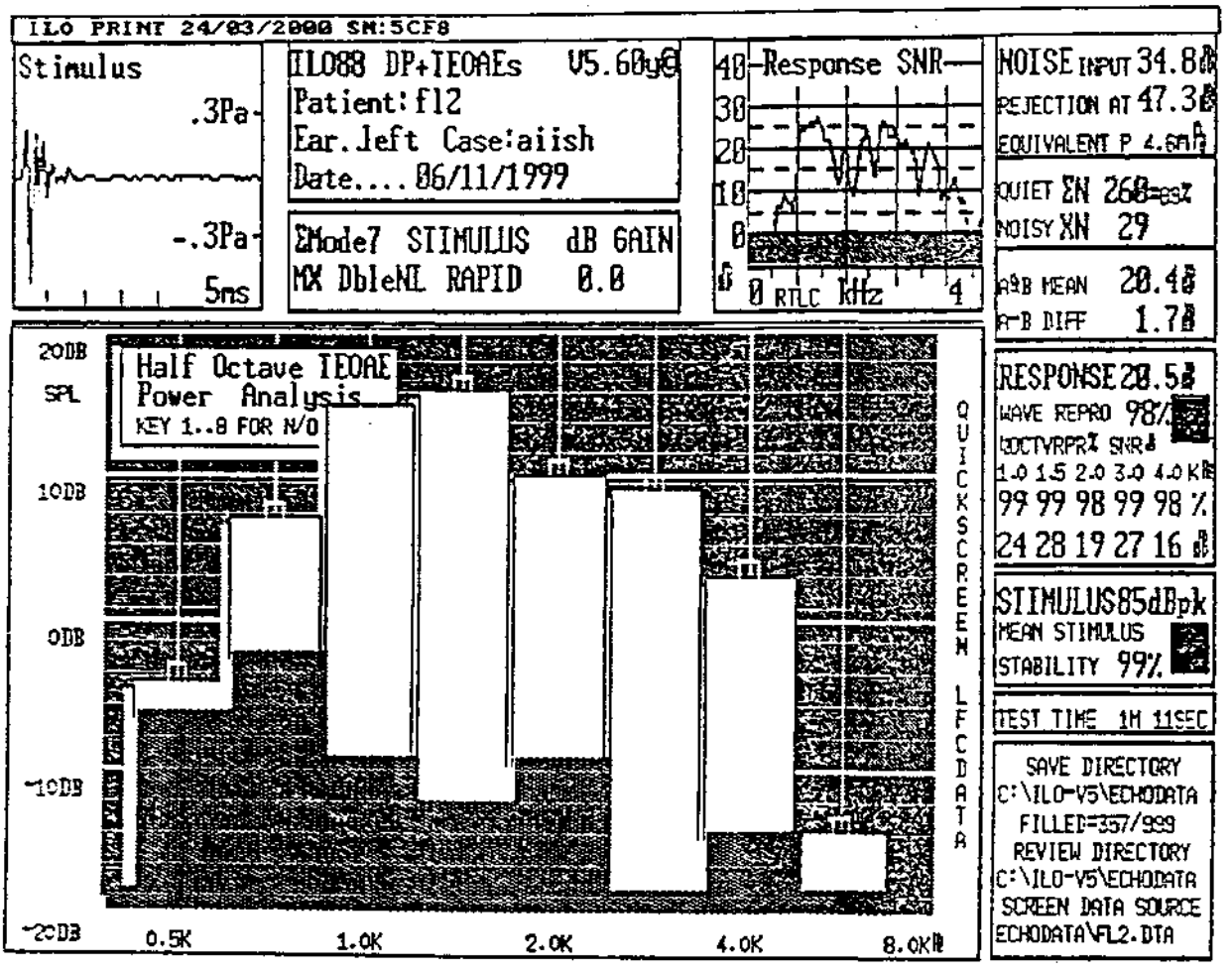


Figure.4 Typical TEOAE amplitude.

RESULTS AND DISCUSSIONS

IV. RESULTS AND DISCUSSION

1) Prevalence of SOAEs:

From the results of the present study it could be inferred that the prevalence of SOAEs in the ears was 27.14% (i.e., 19 out of 70 ears). This is depicted in Table-1.

Table - 1: Indicating the percentage of SOAEs present in total number of ears.

Total No. of ears	SOAEs Present	SOAEs absent	% SOAEs present
70	19	51	27.14%

The present study adopted a criterion of atleast 6 dB difference to be present between the SOAE amplitude and the noise floor, in any frequency ranging from 400 Hz to 7000 Hz.

This finding is consistent with the past studies (Zurek, 1981; Tyler and Conrad - Armes, 1982; Hammel, 1983; Schloth, 1983; Bright and Glattke, 1986; Robinowitz and Widin, 1984; Wier et al. 1984; Dallmayr, 1985; Strickland, et al. 1985; Probst, et al. 1986; Lonsbury-Martin, et al. 1990 b) on the prevalence of SOAEs in

normal hearing human subjects which indicated that SOAEs could be detected in about one-third of the ears.

However, according to the study by Fritze (1983 a,b), the incidence of SOAEs can vary with the use of open microphone systems not coupled to the ear canal. The incidence of SOAEs might also depend on the sensitivity of the recording system.

2) Ear preference for SOAEs:

There was no ear preference for the occurrence of SOAEs (as in Table 2) in these subjects as against the study by Bilger et al. (1990) which stated that the SOAEs are more often observed in right ears than in the left ears.

Table - 2: Indicating number of right and left ears with SOAEs.

Total ears SOAEs present	Right ear	Left ear
19	10	9

3) Gender differences for SOAEs:

There was no gender difference (as in Table 3) in the present study as against the study by Bilger et.al (1990) which stated that twice as many women as men exhibit SOAEs/

Table - 3: Indicating the presence of SOAEs in males and females.

SOAEs present	Males	Females
10 Subjects	5	5

4) Results of the effect of the presence of SOAEs on TEOAE amplitude is indicated in Table-4.

Table - 4: Indicating the effect of presence of SOAEs on TEOAE amplitude,

SOAEs	TEOAE (Mean dB) amplitude	SD	t
Present	14.1	4.79895	0.008
Absent	14.08	5.2747	

All the thirteen subjects had measurable TEOAEs. 't' test revealed no significant difference in the amplitude of TEOAEs when the SOAEs were either present or absent However, there are studies that report significant difference in the TEOAE amplitude in the presence or absence of SOAEs (Osterhammel, 1996; Gobsch and Titze, 1993; Probst et al. 1986) i.e., the amplitude of TEOAEs was significantly higher in ears with SOAEs even when the frequency bands immediately surrounding the SOAE frequency were eliminated from the analysis.

Theoretically, it has been observed that the recording of evoked otoacoustic emissions should be independent of the presence of spontaneous emissions as long as the spontaneous emissions are asynchronous to the stimulus signal.

One reason that could be attributed to the absence of any significant difference is that of the use of two separate instruments for recording SOAEs and TEOAEs.

According to Bonfils et al. (1992), the EOAE amplitude were most influenced by the presence of SOAEs and the Fast Fourier transform (FFT) spectrum, especially the lower limit of the spectrum.

SUMMAR Y AND CONCL US IONS

V. SUMMARY AND CONCLUSION

The study aimed at finding the prevalence of SOAEs in normal hearing adult population age ranging from 18 to 25 years (19 males and 16 females) and also to find out, if any, the effects of the presence or absence of SOAEs on the amplitude of TEOAE.

The study indicated that the prevalence of SOAEs was about 27% of the population studied. Also there was no significant difference in the TEOAE amplitudes when the SOAEs were present or absent.

Thus, the normative data for the TEOAE amplitude remains the same irrespective of the presence or absence of the SOAEs.

RECOMMENDATIONS:

1. The SOAEs and TEOAE recording could be done using the same instrument.
2. More number of subjects with SOAEs presence could be considered, to study the effects of SOAEs presence on TEOAE amplitude.

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