Effect of Audiometric Configuration on Auditory Steady-State and Brain-Stem Response Thresholds

Thesis submitted for partial fulfillment of
The Master Degree of Audiology.

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بسم الله الرحمن الرحيم

قالوا سبحانك لا علم لنا الا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

آية 32 سورة البقرة

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Abbreviations

AEP: auditory evoked potential

AM: amplitude modulation

AM/FM: amplitude modulation / frequency modulation

ASSRs: auditory steady state responses

ASHA: American Speech and Hearing Association

c- ABR: Click- auditory brain stem response

C3: Cervical vertebrae 3

C4: Cervical vertebrae 4

C7: Cervical vertebrae 7

CF: Carrier Frequency

Cz-Mi: vertex-ipsilateral mastoid

dB: decibell

dBHL: decibel hearing level

dB nHL: decibel normal hearing level

dBSPL: decibel sound pressure level

DPOAEs: distortion product otoacoustic emission

EEG: electroencephalography

FM: frequency modulation

F: Frequency

FFT: Fast Fourier Transformation

IAFM: independent amplitude and frequency modulation'

I: Intensity

kH: kilo hertz

MASTER: multiple auditory steady-state response

MC: multi carrier

MEG: magnetoencephalography

MF: Modulation Frequency

MLRs: middle latency responses

MM: mixed modulation

Ms: millisecond

MSC: magnitude-squared coherence test

nV: nanovolt

OAEs: otoacoustic emission

PC: phase coherence test

PTA: pure tone audiometry

OHCs: outer hair cells

S: second

SNR, S/Ns: signal to noise ratio

tb-ABR: tone burst auditory brain stem response

UNHS: Universal Newborn Hearing Screening

INTRODUCTION AND RATIONALE

Over the past decades, the need for objective audiometric techniques in practice has increased. This is partly the result of the growing target population for objective technique after the world-wide introduction of hearing screening in new-born. The most commonly applied technique in this young population is click-evoked auditory brainstem response (c-ABR). However, for an efficient hearing aids fitting, hearing threshold estimates at different octave frequencies are required. Tone-burst-evoked (tb-ABR) and auditory steady-state responses (ASSRs) can provide frequency-specific hearing threshold estimates **(Luts & Wouters, 2005).**

ASSRs are the periodic electrical responses of the brain to auditory stimuli presented at a rate fast enough to cause an overlap of a successive responses (**Stapells et al., 1984; Maiste & Piston, 1989)**. In other words, it is a far field response measured in the background electroencephalogram (EEG) that is elicited by ongoing AM/FM modulated tone that is frequency specific and ear specific from 250 to 8000 Hz at intensity levels that far exceed the output limits of standard ABR **(Ballay et al., 2005)**.

The ASSR technique has several advantages over tone-burst-evoked ABR. Firstly; test clinical duration can be shorter (**Stapells &Oates, 1997**). Secondly, because of the continuous nature of the stimuli used to elicit ASSRs the maximum output level is less restricted compared to tone-burst-evoked ABR. Finally, determination of the ASSR is a statistical finding and doesn't depend on subjective visual examination of the wave forms or response pattern **(Cohen et al., 1991).**

ASSRs thresholds have been shown to be highly correlated to behavioral thresholds in adults and older children, (**Johnson&Brown, 2001; Dimitrijevic et al., 2002; Herdman&Stapells, 2003**) However, individual studies show some variance in the mean difference between ASSR and behavioral thresholds. For example,

Dimitrijevic et al. (2002) reported mean difference of 4 to 17 dB between them whereas **Picton et al. (1998)** found these differences to be ranged from 12 to 27 dB.

It is important to determine whether audiometric configuration has an effect on the correlation between ASSRs and behavioral thresholds (**Vander Werff and Brown, 2005**) and if ASSRs technique is an accurate estimate of audiogram configurations (e.g., rising audiogram, steeply sloping losses, or flat losses). Sloping losses perhaps, present this greatest concern that ASSRs thresholds obtained to high frequency stimuli may actually represent the response of neighboring low-frequency nerve fibers, therefore underestimating the behavioral threshold at the nominal test frequency.

In this study, we are trying to explore the correlation between multiple-stimulus frequency ASSR thresholds and audiometric thresholds and how much it is affected by the audiometric configurations (flat and sloping sensorineural hearing losses).

It is well known that standard ABR is an accurate estimation of frequencies range (2 to 4 kH), so Second goal in this study is to compare hearing thresholds estimated by ASSR to hearing threshold estimated by ABR.

AIMS OF THE WORK

1- To examine the correlation between auditory steady-state response (ASSR) and behavioral thresholds in normal hearing-adults and in subjects with sensorineural hearing loss with two common audiometric configurations (flat and sloping).

2- To compare hearing thresholds estimated by ASSR and hearing thresholds estimated by standard ABR .