

# تقييم الإدراك الوظيفي في مرضى ضعف السمع بعد التأهيل السمعي

رسالة مقدمه من

الطبيبة/ غادة أبو الحديد محمد

توطئة للحصول على درجة الدكتوراه

في

أمراض السمع والصمم

تحت إشراف

الأستاذ الدكتور/ أحمد سامح فريد

عميد طب قصر العيني

كلية الطب - جامعة القاهرة

الدكتورة/ عبير عثمان دبوس

مدرس أمراض السمع والصمم

كلية الطب - جامعة القاهرة

الدكتورة/ أميرة ماجد الشناوي

مدرس أمراض السمع والصمم

كلية الطب - جامعة القاهرة

كلية الطب - جامعة القاهرة (٢٠٠٩)

## **Abstract:**

**Objective:** To study the cognitive functions of rehabilitated hearing impaired (HI) patients using auditory perception skills and P300 event related potential.

**Methods:** Aided speech discrimination score (WDS %) and acoustic P300 were recorded in free field for 40 rehabilitated (hearing aids, cochlear implants) HI adults and compared to 10 normal hearing controls.

**Results:** Rehabilitated HI patients had statistically significant longer P300 latencies and less WDS % compared to the controls. There was no statistically significant difference between mean P300 latency without and with the device at any degree of hearing loss. There was a statistically significant inverse correlation between P300 latency and age of hearing loss and WDS%, and a direct correlation between P300 latency and duration of hearing loss and hearing threshold. There was a statistically significant difference as regards regular use of the device among subjects with different speech performance categories. Subjects who use the device regularly showed higher percentage of positive responses than subjects who don't use it regularly. Subjects with excellent speech performance showed the statistically significant lowest mean P300 latencies.

**Conclusion:** Amplification increases the detectability of P300 and shortens its latency. P300 elicited by tonal contrasts is a neurophysiologic indicator of the discrimination abilities.

***Keywords:*** *cochlear implants, cognitive functions, hearing impaired individuals, hearing aids, P300 cognitive event related potential, speech discrimination.*

# **Assessment of Cognitive Functions in Rehabilitated Hearing Impaired Patients**

Thesis submitted in partial fulfillment for the requirements of  
M.D. Degree in Audiological Medicine

By:

**Ghada Abo-El-Hadid Mohamed**

M.Sc.

Supervised by:

**Prof. Dr. Ahmed Sameh Farid**

Professor of ENT and Audiology  
And Dean of the Faculty of Medicine,  
Faculty of Medicine, Cairo University

**Dr. Abeir Osman Dabbous**

Assistant Professor of Audiology  
Faculty of Medicine, Cairo University

**Dr. Amira Maged El Shennawy**

Lecturer of Audiology  
Faculty of Medicine, Cairo University

Faculty of Medicine  
Cairo University  
2009

## **Acknowledgment**

First and foremost thanks to God, the most merciful. It is my pleasure to acknowledge the help of many in making this work possible.

I would like to express my deepest gratitude and appreciation to **Prof. Dr. Ahmed Sameh Farid** Dean of the Faculty of Medicine, Cairo University, for the supervision of the thesis and for support and advice during all phases of work.

I also wish to express my sincere gratitude to **Dr. Abeir Dabbous** Assistant Professor of audiology, Faculty of Medicine, Cairo University, for her encouragement, suggestions and patience that considerably affected my work.

My deep thanks and gratitude to **Dr. Amira El Shennway** Lecturer of audiology, Faculty of Medicine, Cairo University, for her kindness, patience, meticulous revision and encouragement had really refined this work.

Thanks to my mother, my husband and rest of my family for their encouragement and tolerance. And thanks to every one who gave me a hand in this work.

## **Introduction and Rationale**

Cognitive function is a term used to describe the individual capacity to analyze and utilize the incoming information to coordinate behavior. It constitutes such specific functions such as perception, attention, memory, and complex skills such as reading. Cognitive processing is a complex mental activity that cannot have a single generator structure, but most probably involves a number of areas of cortical and sub-cortical regions (**Musiek and Lee, 1999**).

Hearing impaired individuals' brains process stimuli with greater accuracy and in a more effective manner when these individuals use their personal hearing aids or cochlear implant. The effect on cortical event related potentials (ERPs) and behavioral measures of discrimination are dependent on the degree of sensorineural hearing loss (SNHL), the intensity of the stimuli, and the level of cortical auditory processing that the response measure is assessing (**Korczak et al., 2005**).

P300 is an endogenous component of late evoked response to visual, somato-sensory or auditory task-relevant stimuli. This event-related potential (ERP) closely reflects cognitive functions such as stimulus discrimination and processing as well as attention capabilities (**Franco, 2001**).

P300 could be used to monitor perception abilities, as they offer insight into the complex processing strategies of the auditory system (**Musiek and Lee, 1999**). P300 is an objective test and it can be applied in all age ranges provided that the subjects understand the required task.

P300 provide information about the biological processes underlying speech processing. For this reason, ERPs are of great value to hearing scientists and audiologists to assess the improvements in the neural processing of speech with amplification (hearing aids, cochlear implants) (**Martin et al., 2008**). In hearing impaired subjects who are users of electronic devices, the test should be conducted in free field (**Beynon et al., 2002**).

### **Rationale:**

The study is issued to focus on the cognitive functions of rehabilitated hearing impaired patients.

## **Aim of the Work**

To study the cognitive functions of rehabilitated hearing impaired patients using auditory perception skills and P300 event related potential recorded in free field

## List of Abbreviations

<b>ABR</b>	Auditory Brainstem response
<b>ACE</b>	Advanced Combination Encoder
<b>AEP</b>	Auditory evoked potentials
<b>CAPD</b>	Central Auditory Processing Disorder
<b>CI</b>	Cochlear Implant
<b>CIS</b>	Continuous Interleaved Sampling
<b>CNS</b>	Central nervous system
<b>CNV</b>	Contingent Negative Variation
<b>CT</b>	Computed Tomography
<b>DSP</b>	Digital Signal Processing
<b>Ecoch.G</b>	Electrocochleography
<b>ERP</b>	Event Related Potential
<b>FDA</b>	Food Drug Administration
<b>HA</b>	Hearing Aid
<b>HI</b>	Hearing Impaired
<b>MMN</b>	Mismatch Negativity
<b>MPEAK</b>	Multi PEAK
<b>MRI</b>	Magnetic Resonance Imaging
<b>PBKG</b>	Phonetically Balanced Kinder Garden
<b>SD</b>	standard deviation
<b>SNHL</b>	Sensorineural Hearing Loss
<b>SPEAK</b>	Spectral peak
<b>SPL</b>	Sound Pressure Level
<b>SRT</b>	Speech Reception Threshold
<b>US</b>	United States
<b>WDS%</b>	Word discrimination score percentage



## List of Content

<b>Title</b>	<b>Page No.</b>
<b>LIST OF TABLES</b>	<b>i</b>
<b>LIST OF FIGURES</b>	<b>iv</b>
<b>LIST OF ABBEVIATIONS</b>	<b>vi</b>
<b>INTRODUCTION</b>	<b>1</b>
<b>II. AIM OF THE WORK</b>	<b>3</b>
<b>III. REVIEW OF LITERATURE</b>	<b>4</b>
<b>A. Late evoked potentials</b>	<b>4</b>
▪ Introduction	<b>4</b>
▪ Description of the late auditory potentials	<b>8</b>
<b>B. Auditory event related potential P300</b>	<b>13</b>
▪ Definition	<b>13</b>
▪ Brief history	<b>13</b>
▪ “Odd ball” Paradigm	<b>14</b>
▪ P300 generators	<b>15</b>
▪ Auditory P300 recording procedures	<b>19</b>
▪ Variables affecting auditory P300	<b>21</b>
▪ Clinical application of P300	<b>25</b>
<b>C. Rehabilitated hearing impaired patients</b>	<b>29</b>
▪ Hearing aid technology	<b>31</b>
▪ Cochlear implant	<b>35</b>
<b>D. Role of P300 in assessment of rehabilitated hearing impaired patients</b>	<b>50</b>

<b>Title</b>	<b>Page No.</b>
▪ <b>Role of electrophysiological measures (mainly P300) in assessment of Hearing aid users</b>	<b>51</b>
▪ <b>Role of electrophysiological measures in assessment of CI benefit</b>	<b>53</b>
<b>IV. MATERIAL AND METHODS</b>	<b>57</b>
<b>V. RESULTS</b>	<b>65</b>
<b>VI. DISCUSSION</b>	<b>85</b>
<b>VII. CONCLUSIONS</b>	<b>94</b>
<b>VIII. RECOMMENDATION</b>	<b>95</b>
<b>SUMMARY</b>	<b>96</b>
<b>REFERENCES</b>	<b>99</b>
<b>ARABIC SUMMARY</b>	

## List of Figures

<b>Figure No.</b>	<b>Title</b>	<b>Page No.</b>
Figure (1)	Representative responses from one child to standard /ga/ and deviant /da/ stimuli and the resultant difference wave obtained by subtracting the standard from the deviant waveform.	12
Figure (2)	Schematic illustration of the single-stimulus , oddball down	16
Figure (3)	Schematic illustration of the P300 context-updating model	17
Figure (4)	Schematic representation of brain activation patterns underlying P3a and P3b generation	18
Figure (5)	A graphic explanation of the protocol typically used to evoke a P300 component	24
Figure (6)	Cochlear implant	42
Figure (7)	PTA of the groups under study.	70
Figure (8)	Frequency distribution for the different causes of hearing loss.	72
Figure (9)	P300 latency in msec among different degrees of hearing loss.	74
Figure (10)	P300 latency scores according to speech performance categories	77
Figure (11)	Mean WDS% among different Groups	81
Figure (12)	Mean P300 latency score in msec among different groups	81

<b>Figure No.</b>	<b>Title</b>	<b>Page No.</b>
Figure (13)	Mean duration of hearing loss in years positive and negative responses of P300 test	84
Figure (14)	The percentage of positive and negative responses in P300 test as regards the regular use of the device	84
Figure (15)	Mean WDS% in positive and negative responses of P300 Test	85

## List of Tables

<b>Table No.</b>	<b>Title</b>	<b>Page No.</b>
Table (1)	Comparison of the different quantitative variables among groups 1, 2a and 2B.	68
Table (2a)	Comparison among groups 1, 2A and 2B as regards the gender distribution.	69
Table (3b)	The average hearing threshold level in dBHL at different frequencies in the groups under study.	70
Table (3)	Descriptive statistics for the different quantitative variables in group 2A and 2B.	71
Table (4)	Descriptive statistics for the use of the device in Groups 2A and 2B.	71
Table (5)	Frequency distribution for the different causes of hearing loss in the rehabilitated group (2).	72
Table (6)	Comparison among different degrees of hearing loss as regards P300 Latency scores.	73
Table (7)	Comparison between P300 Latency scores (in msec) between subjects without and with the hearing aid device at different degrees of hearing loss in group 2A.	74
Table (8a)	Comparison of P300 latency in msec among Groups 1 , 2A and 2B .	75
Table (8b)	Comparison of P300 latency in msec between males and females in the normal hearing group (1).	75

<b>Table No.</b>	<b>Title</b>	<b>Page No.</b>
Table (9a)	Comparisons of P300 latency scores among speech performance categories in the whole rehabilitated group and in the subgroups 2A & 2B.	76
Table (9b)	Comparison of P300 latency scores between (group 2A) and (group 2B) at the different speech performance categories.	77
Table (10a)	Comparison among speech performance categories as regards the different quantitative variables in rehabilitated subjects: (Groups 2A & 2B together).	79
Table (10b)	Comparison among speech performance categories as regards the different qualitative variables in rehabilitated subjects: (Groups 2A & 2B together).	80
Table (11a)	Comparison between subjects with positive and negative responses of P300 test as regards the different quantitative variables.	82
Table (11b)	Comparison between positive and negative responses of P300 test as regards the regular use of the device.	83
Table (12)	Correlation between P300 latency and the different quantitative variables in the whole rehabilitated group and the 2 subgroups: (2A) and (2B).	85

Table No.	Title	Page No.
Table (13)	Correlation between P300 latency and The hearing threshold at different frequencies And the average hearing threshold in the hearing-aids users (Group 2A).	87