

**THE CLINICAL VALUE OF AUDITORY STEADY
STATE RESPONSES IN THE AUDIOLOGICAL
ASSESSMENT OF PSEUDOHYPACUSIC
WORKERS WITH NOISE-INDUCED HEARING
LOSS IN THE SOUTH AFRICAN MINING
INDUSTRY**

by

ELIZABETH DE KOKER

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The real secret of success is enthusiasm.

Walter Chrysler

Enthusiasm releases the drive to carry you over obstacles and adds significance to all you do.

Norman Vincent Peale

If you can give your son or daughter only one gift, let it be enthusiasm.

Bruce Barton

You can do anything if you have enthusiasm. Enthusiasm is the yeast that makes your hopes rise to the stars. With it, there is accomplishment. Without it there are only alibis.

Henry Ford

Success is the ability to go from failure to failure without losing your enthusiasm.

Winston Churchill

Knowledge is power, but enthusiasm pulls the switch.

Ivern Ball

2 Kor. 1:3

Aan God, die Vader van ons Here Jesus Christus, kom al die lof toe! Hy is die Vader wat Hom ontferm en die God wat in elke omstandigheid moed gee

**To my parents, Faan and Elsabe Alberts,
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List of abbreviations

A\$	Australian dollar
ABR	Auditory brainstem response
AEP	auditory evoked potential
AM	amplitude modulated
AP	action potential
AR	acoustic reflex
ASSR	Auditory steady state response
AIDS	acquired immune deficiency syndrome
CER	cortical evoked responses
CERA	cortical evoked response audiometry
CNS	central nervous system
COIDA	The compensation of Occupational injuries and diseases Act
CF	carrier frequency
CM	cochlear microphonic
dB	decibel
EAM	external auditory meatus
EcochG	electrocochleogram
EEG	electro encephalogram
ENT	Ear- Nose- and Throat specialist
EP	electrophysiological tests
ERP	event related potential
f	frequency
FM	frequency modulation
FFT	fast fourier transform
GB	giga byte
GGG	geraas-geïnduseerde gehoorverlies
HIV	human immunodeficiency virus
HL	hearing level
HTL	hearing threshold level
Hz	Hertz
IBM	Internationa lbusiness machines
kHz	kilohertz
L	left
LLR	late latency response
MASTER	Multiple auditory steady state response system
MB	mega byte

MF	multiple frequency
MF-ASSR	Multiple frequency auditory steady state response
mg	milligram
MLR	middle latency response
MM	multi-modulation
mg	milligram
ms	millisecond
n	number
NIHL	noise-induced hearing loss
OAE	oto-acoustic emission
OHC	occupational health centre
OMP	occupational medical practitioner
OSR	ouditiewe standhoudende response
P	probability value
PC ²	phase coherence squared
PD	permanent disability
Ps	pseudohypacusis
PT	pure-tone
PTA	pure-tone average
LLR	late latency response
R	rand (South African currency)
RAM	random access memory
RMA	Rand Mutual Assurance
RSA	Republic of South Africa
SD	standard deviation
SIMRAC	Safety in mines research advisory committee
SF	Single frequency
SF-ASSR	single frequency steady state response
SNHL	sensory-neural hearing loss
SP	summating potential
SPAR	sensitivity prediction with the acoustic reflex
SRT	speech reception threshold
SSEP	steady state evoked potential
SVR	slow vertical response
USB	universal serial bus
USA	United States of America
µV	microvolt
WCC	Workmen's Compensation Commissioner

Title : The clinical value of auditory steady state responses in the audiological assessment of pseudohypacusic workers with noise-induced hearing loss in the South African mining industry

Name : Elizabeth de Koker

Supervisor : Prof S.R. Hugo

Co-supervisor : Dr D. Schmulian

Department : Communication Pathology, University of Pretoria

Degree : Doctor Philosophiae

SUMMARY

Large numbers of South African mine workers incur noise-induced hearing loss. The prevalence of noise-induced hearing loss is such that its financial implications for the industry are significant. This situation is often further compounded by an exaggeration of their hearing loss by some workers in an attempt to obtain compensation. Questionable cases must be re-assessed, increasing the cost of evaluations and the number of unproductive shifts.

The inability to obtain true pure-tone thresholds in unco-operative workers leads to ineffectiveness in and frustration for audiologists and occupational health centres because they are not delivering an accountable service to the mining company and individual workers. The failure to obtain pure-tone thresholds may also lead to deserving workers not receiving compensation, and sudden hearing loss not being diagnosed. Workers unfit for their present occupations can also be further exposed to noise.

Current audiological procedures can identify instances of exaggerated hearing loss (pseudohypacusis), but do not quantify the extent of exaggeration.

Traditional testing techniques require patient co-operation and, hence, are insufficient to resolve cases where patient co-operation is not forthcoming.

As a result this study was undertaken to determine the value of auditory steady state responses (ASSRs) as a means of estimating the pure-tone thresholds of noise-exposed workers. ASSRs need no response from the patient, and the electrical responses to the presented sound are measured by means of a real-time statistical analysis of the samples, using a computer, thereby offering real objectivity.

The following research question was addressed: "What is the clinical value of ASSRs in the audiological assessment of pseudohypacusic workers with noise-induced hearing loss?"

An experimental study was conducted, where different protocols and types of equipment used in the testing of ASSRs were evaluated in a group of mine workers with noise-induced hearing loss (n=81). The influence of sedation on the threshold estimation was also evaluated. The proven best protocol was finally evaluated in a pseudohypacusic group of workers (n=29).

The study indicates that ASSRs are a valid and accurate alternative to pure-tone testing in populations with noise-induced hearing loss. The test can serve as a once-off test procedure for an unco-operative client. The mean threshold estimates of ASSRs never differed more than 10 dB from the mean pure-tone thresholds. The test procedure was accurate throughout the severity range of hearing loss, and age did not influence the reliability of the threshold estimates.

Single-frequency techniques were found to be the technique of choice in this population and it is recommended that the 40 Hz response is employed as a modulation frequency. Sedation did not have any effect on the length and the sensitivity of the procedure, and is thus not advocated if co-operation can be obtained. The length of the procedure is estimated at 60 minutes.

Finally, this study has contributed to the validation of the technique (previous research was limited). As a result of this study, the implementation of this procedure in mines' audiological centres is advocated since it has been proven to be of clinical value.

- Titel** : Die kliniese waarde van ouditiwe standhoudende response in die oudiologiese evaluasie van werkers met funksionele en geraas-geïnduseerde gehoorverlies in die Suid-Afrikaanse mynbedryf
- Naam** : Elizabeth de Koker
- Promotor** : Prof S.R. Hugo
- Mede- promotor** : Dr D. Schmulian
- Departement** : Kommunikasiepatologie, Universiteit van Pretoria
- Graad** : Doctor Philosophiae

OPSOMMING

Mynwerkers doen in die loop van ondergrondse werk geraas-geïnduseerde gehoorverlies (GGG) op. Die hoë voorkoms van GGG het finansiële implikasies vir die mynbedryf. Hierdie finansiële implikasies word vererger indien werkers hulle gehoorverlies oordryf om meer vergoeding te kry. Werkers by wie daar nie akkurate gehoordrempels vasgestel kon word nie, moet herevalueer word en so eskaleer kostes verder.

Dit is verstaanbaar dat 'n onvermoë om drempels by 'n werker te bepaal tot frustrasie en 'n gevoel van oneffektiwiteit bydra, wat die oudioloog en ook die beroepsgesondheidsklinieke direk raak. Die oudioloog is immers daarvoor verantwoordelik om 'n toerekenbare diens aan die werkgewer en individuele werkers te lewer. 'n Onvermoë om gehoordrempels te bepaal het ook tot gevolg dat werkers met GGG nie die kompensasie wat hulle toekom kry nie en 'n skielike gehoorverlies kan ongediagnoseerd bly. Werkers met ernstige

gehoorverlies, word by die gebrek aan akkurate gehoordrempels, verder aan skadelike geraas blootgestel.

Huidige gehoortoetse kan funksionele gehoorverlies identifiseer, maar kan dit nie kwantifiseer nie. Lug- en beengeleidingstoetse word internasionaal as die norm aanvaar, maar vereis samewerking van die pasiënt.

'n Studie is gevolglik onderneem om die waarde van ouditiwe standhoudende response (OSR) in die oudiologiese evaluasie van werkers met GGG te bepaal en die vraag is spesifiek of die OSR akkurate drempels, in hierdie volwasse bevolking, kan bepaal. Die veronderstelling is dat ouditief ontlokte potensiale objektief is en dat geen respons van die pasiënt verwag word nie. OSR het ook 'n verdere dimensie in objektiwiteit waar die elektriese response, met statistiese ontleding, deur 'n rekenaar gemeet word.

Die navorsingsvraag wat dus aangespreek word is: "Wat is die kliniese waarde van OSR in die oudiologiese evaluasie van mynwerkers met funksionele komponente tot GGG?"

'n Eksperimentele studie het gevolg waar verskillende toetsprotokolle en apparatuur gebruik is in die evaluasie van mynwerkers met GGG (n=81). Die invloed wat sedasie op die drempelbepalings gehad het, is ook evalueer. Die beste protokol is vervolgens ook in 'n groep mynwerkers (n=29) met funksionele gehoorverlies getoets.

Die studie het bewys dat OSR 'n geldige en akkurate alternatiewe toets vir suiwer-toonoudiometrie, in 'n volwasse bevolking met GGG is. Die toets kan as 'n enkeltoets funksioneer indien die pasiënt sawewerking weerhou. Die gemiddelde drempelskattings van OSR het nooit meer as 10 dB van die suiwer-toondrempels verskil nie. Skattings van gehoordrempels was moontlik by alle grade en erns van gehoorverlies. Verder het die ouderdom van werkers nie 'n invloed op die akkuraatheid van die drempelskattings gehad nie.

Daar word aanbeveel dat die enkelfrekwensie-tegniek (monoraal) en spesifiek die 40 Hz respons gebruik word. Sedasie het geen invloed op die akkuraatheid van die drempelskattings en die toetstyd gehad nie en daarom word sedasie nie aanbeveel as passiewe samewerking van die pasiënt teenwoordig is nie. Die prosedure het ongeveer 60 minute geneem.

Die huidige studie het verder bygedra tot die beperkte kliniese validasie wat nog ten opsigte van OSR bestaan. Op grond van hierdie studie word die implementering van hierdie tegniek in die Suid-Afrikaanse mynwese aanbeveel, aangesien die kliniese waarde daarvan bewys is.