THE CLINICAL VALUE OF THE AUDITORY STEADY STATE RESPONSE FOR EARLY DIAGNOSIS AND AMPLIFICATION FOR INFANTS (0 – 8 months) WITH HEARING LOSS

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For Frederick, Nell and Mieke

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SUMMARY

TITLE	:	**THE CLINICAL VALUE OF THE AUDITORY STEADY STATE RESPONSE FOR EARLY DIAGNOSIS AND AMPLIFICATION FOR INFANTS (0 – 8 months) WITH HEARING LOSS**
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There has always been a need for objective tests that assess auditory function in infants, young children, and/or any patient whose development level precludes the use of behavioral audiometric techniques. Although the Auditory Brainstem Response (ABR) is seen as the 'gold standard' in the field of objective audiometry, it presents with its own set of limitations. The Auditory Steady State Response (ASSR) has gained considerable attention and is seen as a promising addition to the AEP 'family' to address some of the limitations of the ABR. The ASSR promises to estimate all categories of hearing loss (mild to profound) in a frequency specific manner. It also indicates to the possibility to validate hearing aid fittings by determining functional gain of hearing aids by determining unaided and aided ASSR thresholds.

An exploratory research design was selected in order to compare unaided thresholds, obtained through the use of three different procedures – ABR, ASSR and behavioral thresholds. Aided thresholds were also obtained and compared with two procedures – the aided ASSR

(measured and predicted) and aided behavioral threshold. The results indicated that both the ABR (tone burst and click) and ASSR provided a reasonable estimation of the subsequently obtained behavioral audiograms. The ASSR, however, approximated the behavioral thresholds closer than the ABR and were furthermore able to quantify hearing thresholds accurately for subjects with severe and profound hearing losses. The result indicated further that the ASSR can be instrumental in the validation process of hearing aid fittings in infants. These results demonstrated however, that the ASSR measured thresholds underestimate the aided behavioral thresholds and the aided ASSR predicted thresholds overestimate the aided behavioral thresholds.

The research concluded that the ASSR is useful in estimating frequency-specific behavioral thresholds accurately in infants and validating hearing aid fittings. Until evidence is sufficient to recommend the ASSR as primary electrophysiological measure of hearing in infants, the ASSR should be used in conjunction with the ABR – following a test battery approach in the diagnostic process of hearing loss in infants. The ASSR further shows great promise in validating hearing aid fittings, but this specific application of the ASSR needs further research evidence on large groups to validate the procedure.

Key terms: Objective tests, estimate behavioral thresholds, auditory brainstem response, auditory steady state response, frequency specific, test battery, validation of hearing aids, ASSR measured thresholds, ASSR predicted thresholds, auditory evoked potentials.

OPSOMMING

TITEL	**:**	**DIE KLINIESE WAARDE VAN DIE OUDITIEF STANDHOUDENDE RESPONS VIR VROEË IDENTIFIKASIE VAN GEHOORVERLIES EN VROEË PASSING VAN GEHOORAPPARATE IN DIE JONG BABA (0 – 8 maande)**
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In die veld van Oudiologie is daar ‘n voortdurende behoefte na objektiewe oudiometriese prosedures om ouditiewe sensitiwiteit in babas, jong kinders en/of enige pasiënte wie se ontwikkelingsvlak hul uitskakel van gedragsoudiometrie, te bepaal. Die Ouditiewe Breinstam Respons (OBR) word gesien as die “goue standaard” in die veld van objektiewe oudiometrie, alhoewel die tegniek sy eie beperkinge voorhou. Die Ouditiewe Standhoudende Respons (OSR), het aansienlike aandag begin geniet en word gesien as ‘n belowende toevoeging tot die ‘familie’ van Ouditief Ontlokte Potensiale (OOP), wat gevolglik sekere van die OBR se tekortkominge kan aanspreek. Die OSR blyk ‘n ouditief ontlokte respons te wees wat spesifiek geskik is om alle kategorieë van gehoorverlies frekwensie-spesifiek te voorspel. Daar is ook aanduidings dat die OSR geskik mag wees om passings van gehoorapparate by jong babs te bevestig, deur beide onversterkte en versterkte OSR drempels te bepaal.

‘n Ondersoekende navorsingsontwerp is gebruik om onversterkte drempels, soos bepaal deur drie verskillende prosedures – OBR, OSR en gedragsoudiometrie – te bepaal en te vergelyk. Versterkte drempels is ook bepaal en vergelyk deur middel van twee prosedures, naamlik die versterkte OSR (meting en voorspelling) en versterkte gedragsoudiometrie. Die resultate het getoon dat beide die OBR (toonbreuk en klik) en die OSR ‘n redelike beraming van suiwertoon gedragsoudiometrie vertoon. Die OSR het egter die suiwertoondrempels meer akkuraat beraam en was daartoe instaat om die erge en uitermatige gehoorverliese te kwantifiseer. Die resultate het verder daarop gedui dat die OSR ‘n rol kan speel in die bevestiging/validasie van gehoorapparaatpassings in babas. Die resultate het gedui daarop dat die OSR meting die versterkte gedragsoudiometrie drempels onderskat, terwyl die OSR voorspelde drempels die versterkte gedragsoudiometrie drempels oorskat.

Die navorsing het bevind dat die OSR nuttig is om frekwensie-spesifieke suiwertoondrempels akkuraat vir babas te voorspel. Die OSR toon ook waarde in die validasie-proses wanneer gehoorapparate gepas word. Verdere navorsing is egter nodig alvorens die OSR as primêre elektrofisiologiese prosedure aanbeveel kan word om gehoor van babas te evalueer. Dit is duidelik dat die OSR deel van ‘n toets-battery benadering moet wees om gehoorsensitiwiteit van babas te evalueer. Die OSR dui verder daarop dat dit ‘n rol kan speel in die validasie-proses wanneer gehoorapparate gepas word, maar dat hierdie toepassing van die tegniek verdere navorsing benodig. Validasie daarvan op groot groepe is nodig.

Sleutelwoorde: Objektiewe oudiometrie, beraming van suiwertoondrempels, ouditiewe breinstam respons, ouditiewe

standhoudende respons, frekwensie-spesifiek, toetsbattery, validasie van gehoorapparate, OSR meting, OSR voorspelling, ouditief ontlokte potensiale.

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LIST OF ABBREVIATIONS

AABR	-	Automated Auditory Brainstem Response
ABG	-	Air Bone Gap
ABR(s)	-	Auditory Brainstem Response(s)
AC	-	Air Conduction
AEP(s)	-	Auditory Evoked Potential(s)
AER	-	Auditory Evoked Response
AM	-	Amplitude Modulation
ASSR(s)	-	Auditory Steady State Response (s)
BC	-	Bone conduction
BT	-	Behavioral Threshold
CF(s)	-	Carrier Frequency (s)
CNS	-	Central Nervous System
dB	-	Decibel
eCochG	-	Electrocochleography
EEG	-	Electro-Encephalo-Gram
EOAE	-	Evoked Oto-acoustic Emissions
FFR	-	Frequency Following Response
FFT	-	Fast Fourier Transform
FM	-	Frequency Modulation
HL	-	Hearing Level
Hz	-	Hertz
IAFM	-	Independent Amplitude and Frequency Modulation
JCIH	-	Joint Committee on Infant Hearing
Kg	-	kilogram
kHz	-	Kilo Hertz
kOhms	-	Kilo Ohm

L	-	Left
L-I	-	Latency Intensity
LLR	-	Late Latency Response
MASTER	-	Multiple auditory steady-state response
MF(s)	-	Modulation Frequency (s)
mg	-	milligram
MLR	-	Middle Latency Response
ms	-	Millisecond
n	-	Number
nHL	-	Normal Hearing Level
NICU	-	Neonatal Intensive Care Unit
NR	-	No Response
OAE(s)	-	Oto-Acoustic Emission (s)
PC	-	Phase Coherence
R	-	Right
s	-	Second
sec	-	Second
SD	-	Standard Deviation
SLR	-	Short Latency Responses
SN_{10}	-	Slow-negative Potential
SNHL	-	Sensory Neural Hearing Loss
SPL	-	Sound Pressure Level
SSP	-	Steady State Potential
SSEP		Steady State Evoked Potential
TB	-	Tone Burst
UNHS	-	Universal Newborn Hearing Screening
USA	-	United States of America
WRS	-	Word Recognition Scores