



AMERICAN
SPEECH-LANGUAGE-
HEARING
ASSOCIATION

Guidelines for Competencies in Auditory Evoked Potential Measurement and Clinical Applications

*Ad Hoc Committee on Auditory Evoked Potentials, American Speech-Language-
Hearing Association*

Reference this material as: American Speech-Language-Hearing Association. (2003). *Guidelines for Competencies in Auditory Evoked Potential Measurement and Clinical Applications* [Knowledge and Skills]. Available from www.asha.org/policy.

Index terms: auditory evoked potential, assessment

DOI: 10.1044/policy.KS2003-00020

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About This Document

These guidelines are an official statement of the American Speech-Language-Hearing Association (ASHA). They provide guidance on auditory evoked potential measurement but are not official standards of the Association. The guidelines were developed by ASHA's Ad Hoc Committee on Auditory Evoked Potentials. Members of the committee were Bopanna B. Ballachanda, Margie R. Crawford, John A. Ferraro, Scott K. Griffiths, Roger Ruth (chair), and Maureen E. Thompson (ex-officio). Vice presidents for professional practices in audiology, Richard Nodar (1998–2000) and Susan J. Brannen (2001–2003), served as monitoring vice presidents.

The ASHA Scope of Practice for Audiology states that the practice of audiology includes providing auditory evoked potential assessment. The Preferred Practice Patterns for the Profession of Audiology are statements that define universally applicable characteristics of practice. The guidelines within this document fulfill the need for more specific procedures and protocols when auditory evoked response procedures are indicated. It is required that individuals who practice independently in this area hold the Certificate of Clinical Competence in Audiology and abide by the ASHA Code of Ethics, including Principle of Ethics I, Rule A and Principle of Ethics II, Rule B.

Background

The American Speech-Language-Hearing Association (ASHA) Ad Hoc Committee on Auditory Evoked Potentials was charged with revising the existing ASHA policy document, "Competencies in Auditory Evoked Potential Measurement and Clinical Applications" and the tutorial, "Short Latency Auditory Evoked Potentials."

ASHA's Certificate of Clinical Competence in Audiology (CCC-A) ensures that audiologists have met all the education, knowledge, and experience requirements established by the Association for providing basic clinical services in the profession of audiology. However, all audiologists interested in performing auditory evoked potential measures must ensure that they have acquired the knowledge and skills outlined in this document. Levels of experience, skill, and knowledge may differ greatly among audiologists working actively in the area of auditory evoked potential measurement and interpretation.

The ASHA Code of Ethics (ASHA, 2003) states:

Principle of Ethics I: Individuals shall honor their responsibility to hold paramount the welfare of the persons they serve professionally or participants in research and scholarly activities and shall treat animals involved in research in a humane manner.

Rules of Ethics A: Individuals shall provide all services competently.

Principle of Ethics II: Individuals shall honor their responsibility to achieve and maintain the highest level of professional competence.

Table 1. Auditory Evoked Potentials Measurements

AEP measurements	Latency Epoch	Latency Range
Electrocochleography (EcochG) CM, SP, AP, (N1, N2)	First	0–2ms
Auditory Brainstem Response (ABR) Fast I-VII		< 10 ms
Middle Latency Response (MLR) No, Po, Na, Pa, Nb, Pb	Middle	8 – 80 ms
Exogenous Late Potentials (ALR) P1, N1, P2, N2	Slow	50 – 300 ms
Mismatched Negativity (MMN) Endogenous Late Potentials P3007 CNV	Late	250 + ms
Other: Electrically Evoked Auditory Potentials		

Introduction

Rules of Ethics B: Individuals shall engage in only those aspects of the professions that are within the scope of their competence, considering their level of education, training, and experience.

In preparing these guidelines, there was no intent on the part of the committee to imply that all audiologists are prepared to conduct the measurements described.

Over the past several decades, measurement of auditory evoked potentials (AEPs) has become routine clinical audiologic practice. Audiologists are responsible for evaluating auditory function; therefore, the use of AEP measures to evaluate auditory function naturally falls within the scope of audiologists. To be competent, the audiologist must receive proper training—whether formally or informally—in AEP measurement and interpretation, obtain adequate experience to attain proficiency in the use of AEP measurement, and continue to develop knowledge and skills in this area.

It is the purpose of this statement to outline the various competencies minimally requisite for AEP measurement and clinical applications. The AEP measurements addressed in this document are listed in Table 1. Background information for these competencies is given in the tutorial document, “Auditory Evoked Potentials.” The Committee has identified four major roles, each involving various competencies. A rationale, the competencies per se, and the requisite background knowledge and skills are provided for each major role.

Major Role

1.0 Role: Identification of Patients for Whom AEP Evaluations are Appropriate

Rationale: Audiologists identify individuals for whom AEP evaluations are appropriate. In situations where a patient is referred to an audiologist, the audiologist must ensure that the referral is appropriate. The audiologist is responsible for the administration and interpretation of test results.

Competencies include:

- A. Recording and interpretation of case history information
- B. Interpretation of audiologic test results
- C. Recognition of symptoms of auditory and/or vestibular dysfunctions
- D. Recognition of conditions that may alter the functional integrity of the auditory system
- E. Recognition of conditions in which AEP measurements are indicated to supplement other audiologic test findings
- F. Recognition of strengths and limitations of AEP evaluations

Knowledge Base and Skills Required:

1.1 Basic knowledge of:

- a. Anatomy, physiology, and electrophysiology of the peripheral and central components of the auditory and vestibular systems and normal life-span changes in these systems
- b. Conditions related to the auditory and vestibular systems and the nervous system in general
 - 1. Diseases and/or pathologies including developmental, degenerative, and hereditary defects
 - 2. External agents (e.g., ototoxicities, noise)
 - 3. Medical and/or surgical intervention

1.2 Knowledge of manifestations of pathologies related to the auditory system

1.3 Understanding of the conventional audiologic procedures as defined in Appendix A, which consists of procedures 07.0 Basic Audiologic Assessment, 08.0 Advanced Audiologic Assessment, and 09.0 Pediatric Audiologic Assessment of the ASHA's "Preferred Practice Patterns for the Profession of Audiology" (ASHA, 1997)

1.4 Knowledge of the strengths and limitations of conventional audiologic procedures:

- a. Subject-related variables (e.g., age, developmental level, peripheral and/or central auditory disorders, physical disability)
- b. Test-related variables (e.g., reliability, validity)

1.5 Knowledge of strengths and limitations of AEP evaluations:

- a. Subject-related variables (e.g., age, developmental level, peripheral and/or central auditory disorders, physical disability)
- b. Test-related variables (e.g., reliability, validity)

2.0 Role: Identification and Administration of Appropriate Test Procedures and Strategies

Rationale: When conducting an AEP evaluation, the audiologist must be knowledgeable in the selection of the appropriate AEP test(s) and must choose the appropriate methods, including stimulus and recording parameters. Audiologists must adhere to any and all relevant standards pertaining to instrumentation, calibration, and safety (see Appendix B).

Competencies include:

- A. Selection of the appropriate AEP(s)
- B. Selection of the method(s) involved in the administration of the appropriate AEP(s)
- C. Data analysis, interpretation, and reporting

Knowledge Base and Skills Required:

- 2.1 Basic Knowledge of the Clinical Applications:
 - a. Fundamentals of electricity/electronics
 - b. Fundamentals of acoustics
 - c. Fundamentals of electrophysiology and neurophysiology
 - d. Basic understanding of the various AEPs, including their neural substrates and underlying physiological mechanisms
 - e. Comprehensive knowledge base and ability to administer the AEP evaluations in common clinical usage
 - f. Established clinical applications of each AEP
- 2.2 Knowledge of Stimulus Characteristics:
 - a. Type of stimulus:
 - 1. Transient (e.g., clicks, noise bursts, tone bursts)
 - 2. Tonal (e.g., continuous, modulated)
 - 3. Complex (e.g., linguistic, nonlinguistic)
 - 4. Electrical stimuli
 - b. Stimulus Characteristics:
 - 1. Intensity
 - 2. Frequency
 - 3. Duration
 - 4. Envelope
 - 5. Polarity/phase
 - 6. Repetition rate and/or interstimulus interval
 - c. Stimulus Delivery:
 - 1. Mode of stimulation (e.g., air, bone, electrical)
 - 2. Transducer type (e.g., supraural, insert, bone)
 - d. Limitations of stimulus instrumentation (e.g., output limits and constraints on stimulus production)
 - e. Calibration procedures and available standards
- 2.3 Knowledge of Recording Parameters:
 - a. Electrodes:
 - 1. Types (e.g., cup/ needle, material)
 - 2. Electrode-skin interface
 - 3. Impedance
 - 4. Cleansing
 - b. Electrode montage:
 - 1. International 10–20 system (Jasper, 1958)
 - 2. Number of channels (e.g., location, ipsilateral versus contralateral)
 - c. Amplification:
 - 1. Differential amplification
 - 2. Common mode rejection
 - 3. Gain
 - 4. Calibration
 - d. Filtering:
 - 1. Online versus post hoc
 - 2. Consideration of choice of filter parameters based on AEP spectrum
 - 3. Effects of filter characteristics (e.g., slope, pass band)

4. Line frequency (e.g., 60 Hz)
 5. Analog versus digital
 - e. Fundamentals of signal averaging and related aspects:
 1. Analog-to-digital conversion
 2. Signal-to-noise ratio
 3. Sampling window
 4. Number of sweeps/average
 5. Artifact rejection
 - f. Electrical and acoustical shielding techniques (including familiarity with effects of ambient noise):
 1. Acoustically treated environment
 2. Electrically shielded environment (e.g., shielding/grounding of earphones and electrodes)
 - g. Methods of data storage and output
- 2.4 Knowledge of Subject Variables:
- a. Subject state (e.g., level of arousal, attention, temperature)
 - b. Peripheral hearing loss (type, degree, and configuration)
 - c. Central auditory disorders
 - d. Underlying medical condition(s) (e.g., tumors, multiple sclerosis)
 - e. Age (e.g., central nervous system maturity)
 - f. Cognitive development/abilities (e.g., discrimination ability during event-related potentials)
 - g. Medication that may influence AEPs
 - h. Gender
 - i. Physical anomalies (e.g., collapsing canals and atresia)
- 2.5 Knowledge of Procedures Related to Subject Preparation:
- a. Precautionary steps and safety measures related to the use of electronic instrumentation techniques
 - b. Sedation/anesthesia (see Appendix C):
 1. Effect on AEPs
 2. Patient safety considerations
 - c. Skin preparation and possible patient reaction (e.g., allergy, infection)
 - d. Infectious disease control (see Appendix D)
 - e. Instruction and explanation of test procedures
 - f. Positioning and comfort

3.0 Role: Analysis and Interpretation of AEP Findings

Rationale: Analysis and interpretation requires identification of a given AEP and its component waves, and measurement of relevant parameters. The results must be interpreted with respect to their indication of the presence or absence of conductive, cochlear, retrocochlear, and/or central auditory disorder. Where appropriate and to whatever extent possible, the probable site or level of lesion should be determined from AEP results in conjunction with other audiologic test findings. Additionally, it may be necessary to estimate hearing sensitivity from evoked potential measurements. This role requires the ability to evaluate the quality of the results obtained from a given AEP test.

Competencies include:

- A. Identification of the waveform

- B. Measurement of response parameters
- C. Interpretation of results:
 - 1. Presence of pathology
 - 2. Site of lesion
 - 3. Estimate of hearing sensitivity
 - 4. Identification of central auditory disorders
 - 5. Monitor specific auditory neurophysiologic status during surgical procedures
 - 6. Correlation with other audiologic and laboratory findings

Knowledge Base and Skills Required:

- 3.1 Knowledge of strategies to verify waveform identification and/or increase reliability:
 - a. Repeat runs
 - b. Latency-intensity function
 - c. Multichannel recordings
- 3.2 Ability to recognize the response waveform:
 - a. Post hoc noise reduction:
 - 1. Digital Filtering
 - 2. Waveform manipulation (e.g., adding and subtracting)
 - 3. Signal processing techniques
 - b. Ability to distinguish response from background noise (i.e., electrical, other artifacts, EEG, etc.)
 - c. Ability to identify the target response/component
- 3.3 Knowledge of relevant response parameters and how to measure them:
 - a. Response present/absent
 - b. Wave morphology
 - c. Latencies (absolute, relative, interaural measures)
 - d. Amplitudes (absolute, relative, area measures)
 - e. Response threshold
- 3.4 Knowledge of relevant statistical methods and measures:
 - a. Parameters of normative data collection (e.g., sample size)
 - b. Statistical analysis of data and characterization of normal variability (e.g., confidence limits)
 - c. Selection of criteria for judgment of normality versus abnormality of a given subject's findings
 - d. Selection of criteria to determine presence of cochlear, retrocochlear, and central auditory disorders
 - e. Knowledge of relations among AEP findings and other audiologic test results

4.0 Role: Reporting of Findings and Recommendations

Rationale: Findings should be reported and recommendations for appropriate follow-up should be made. The report should include information concerning any limitations in the data, circumstances of the recording, and any technical problems.

Competencies Include:

- A. Organization and communication of results

B. Identification of the need for follow-up

Knowledge Base and Skills Required:

- 4.1 Knowledge of:
 - a. Clinical significance of findings
 - b. Report format and composition including purpose, procedural and subject influences, findings, and limitations
- 4.2 Knowledge of:
 - a. When to reevaluate
 - b. When to perform follow-up evaluations (conventional audiologic evaluations, additional AEP evaluations (see Appendix A))
 - c. Appropriate medical referral criteria
 - d. Appropriate (re)habilitative follow-up

Conclusion

Competent performance and clinical application of AEP measurements involve a broad background of knowledge and a range of skills. The purpose of this document is to identify essential elements of competencies that are necessary for proper training and professional development in this area. The majority of training and practical experience required to obtain the knowledge and skill areas outlined in this document can be obtained through graduate-level courses in audiology. Other professionals in related fields may be involved in the measurement and interpretation of auditory evoked potentials, and it is not ASHA's intent to exclude their participation.

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Appendix A

American Speech-Language-Hearing Association. (1997). *Preferred practice patterns for the profession of audiology*. Rockville, MD: Author.

Appendix B

American Speech-Language-Hearing Association. (1947). *Professional services board standards and accreditation manual*.
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Appendix C

American Speech-Language-Hearing Association. (1992, March). Sedation and topical anesthetics in audiology and speech-language pathology. *Asha*, 34(Suppl. 7), 41-42.

Appendix D

American Speech-Language-Hearing Association. (1989, June/July). AIDS/HIV: Implications for speech-language pathologists and audiologists. *Asha*, 31, 33-38.