A NEW METHOD OF ANALYZING EVOKE D AUDITORY SYSTEM ACTIVITY DURING SLEEP, WITH CONTINUOUS SUPRA-FUSION STIMULATION. Jewett DL1, Larson-Prior LJ1, Hart MT2, McCutchen C3, Black JE2,4. 1Washington Univ. at St. Louis, MO, 2Abratech Corp., Sausalito, CA, 3Consultant, 4 Sleep Disorders Clinic, Stanford Univ., Palo Alto, CA

1. INTRODUCTION

We present data utilizing a new method of studying auditory system activity during sleep and wakefulness, which shows correlations with standard PSG staging, but also shows differences that may prove valuable.

Middle-late auditory evoked responses averaged to brief repeated stimuli are usually elicited at stimulation rates below 10/sec because the responses can last up to 100 ms. Such rates are below stimulus fusion (~20/sec). A new stimulation analysis method called QSD (q-sequence deconvolution) has been developed that permits recovery of the transient evoked-responses at rates as high as 100/sec despite response overlap. These responses are hypothesized to be a product of CNS processing of “background” sounds that are continuous, such as heating or cooling system noise. A series of 4-6 waves with periods in the gamma-frequency range are observed in the first 100 ms after a chirp or tone-pip stimuli presented at 40/sec, which we call “G-waves”.

We have undertaken preliminary studies to determine whether these QSD-derived G-wave responses may have interest or utility to those interested in sleep research and its clinical applications.

2. MATERIALS AND METHODS

A. SUBJECTS

17 healthy young adults (7 female; ages 23-46) with normal hearing and no history of sleep problems participated in these studies. Subjects gave informed consent under an IRB-approved protocol and were reimbursed for their participation. Subjects were instrumented for EEG sleep recordings using standard techniques. All subjects slept one night in the laboratory without auditory stimulation. For nights in which auditory stimuli were present, subjects were instrumented with an independent electrode array in which bipolar recordings were taken from 4 channels (C3-A2; C4-A1; C3’-O2; C4’-O1; modified 10-20 array) to recover auditory evoked potentials (AEPs).

B. STIMULATION AND RECORDING

Stimuli (rising chirps 0.5-15 kHz, 4 msec duration, 30 or 42 dB SL, 40/sec or 70/sec) were delivered monaurally via Etymotic tubephone to the right ear as the subjects lay comfortably in an acoustically shielded chamber. AEPs were recorded 10 minutes prior to lights out as a waking control. Subjects then slept through the night. AEPs were recovered from raw EEG (24-bit resolution, 48 kHz sampling rate) continuously through the night. In some subjects (n=6) AEPs were also recorded immediately following morning wakening and again 20 minutes later. Sleep data were acquired continuously (Sandman Elite system) through the night using standard techniques. Subjects were not instrumented for respiration in these studies.

C. DATA PROCESSING

AEP files were processed using the q-sequence deconvolution method (QSD) diagrammed below. Data were filtered offline (25-150 Hz) for recovery of middle latency G-wave responses. For analysis, single channels were added (square root of the sum of the squares point by point) to create vector sums of 2 (bi) or 4 (quad) channels. Somnographic data were collected continuously through the night and scored in 30 second epochs. AEP data were acquired in 45 min. segments and averaged on 1 minute intervals to enable registration with somnographic data for post-processing analysis. These data were compressed as illustrated below. A sleep histogram was constructed and time-locked to AEP data for each channel. These data formed the basis for further analyses.

D. EFFECT OF CHANGES IN INTENSITY OR RATE

In 6 subjects, data was obtained for two stimulus intensities (30 dB SL & 42 dB SL) and two rates (A. 40/sec & B. 70/sec). These data showed significant increases in total sleep time (p<0.05, both rates) and SWS (p<0.05, 70/sec) for the 42dB SL stimulus.

4. CONCLUSION

Evaluation of the effects of an increasingly noisy environment on sleep have become important in furthering our understanding of what constitutes adequate sleep in human populations. We have reported a new tool to aid in such studies, illustrating that even low intensity noise can affect sleep architecture.

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