INTRODUCTION

Recent neuroimaging studies have demonstrated that some patients with disorders of consciousness (DOC) may have significant cognitive abilities that may be masked by their limited motor abilities. Thus, the development of electroencephalographic (EEG) measurements to evaluate their cognitive abilities, as an alternative to ordinary bedside testing, is important. Previous studies of DOC subjects have shown a selective EEG response to presentation of speech stimuli in a substantial proportion of the subjects studied. Measuring brain responses to music is likely to represent a complementary assay of cognitive function in DOC patients, because music represents a domain that is independent of language. Neuro-anatomical differences in cortical processing of language and music also suggest that EEG assessments of these domains are independent probes of the integrity of integrative cortical response to auditory stimuli.

METHODS

Recording

EEG was recorded using 37 electrodes silver-collodion disc electrodes placed in an enhanced 10-20 system using the Natus XLT Ex system in the patient subjects. In normal controls, EEG was recorded using the 128 channel HydroCel Sensor net. Signals were amplified and digitized at 250 Hz. Simultaneous video recordings were obtained.

Speech Stimuli

Subjects listened to 2-3 minute, personally meaningful stories recorded by family members, alternating with time-reversed versions of the same recordings. Time-reversed stories serve as a useful control condition as they preserve many of the basic acoustical properties of spoken language, without syntactic or semantic content.

Music Stimuli

Subjects listened to two pieces of music on each of the 3 trials per testing session (2 - 3 sessions per patient). Subjects listened to one piece of music that was personally meaningful, and another that was unfamiliar to them, each lasting 1-2 minutes.

Analysis

We calculated power spectral density for each Hjorth Laplacian channel, each lasting 1-2 minutes.

RESULTS

PS 1

- Right-handed male with trauma followed by vasospasm with ischemia to entire right hemisphere, cerebral hemorrhage and herniation.
- Behavioral assessments using JFK Coma Recovery Scale demonstrated evidence for emergence from minimally conscious state (ex: functional object use), with CRS-R motor function subscale score ≤ 6 on some but not all examinations.
- Resting metabolic activity measured by 18F-DG-PET in the left hemisphere showed a normal pattern, while the right hemisphere demonstrated only small regions of metabolic activity in remaining midline cortical regions.

PS 2

- Probable hypoxic ischemic injury.
- Behavioral assessments showed evidence of the minimally conscious state (MCS) (CRS-R score ≤ 9). Patient had emotional reactions at bedside (smiling and laughter) when humorous stimuli were presented.

SUBJECTS

7 control subjects (NC 1-7) and 2 patients in the minimally conscious state (PS 1-2) were studied.

CONCLUSION

- In PS 1, power spectrum shows relative desynchrony during the presentation of personally meaningful music in occipital channels in the left hemisphere in the frequency range 4 - 12 Hz.
- In PS 2, power spectrum shows relative synchrony during the presentation of personally meaningful music in occipital channels in both hemispheres in the frequency range 14 - 30 Hz.
- These findings demonstrate that some patients with severe brain injury manifest an EEG response to personally meaningful music, whose spectral and topographic characteristics are distinct from the EEG response to personally meaningful speech.

Control Subject Age/Gender Handedness Musician

NC1 55/M R Y
NC2 29/M R T
NC3 23/M R N
NC4 36/M L N
NC5 19/F R N
NC6 18/F R T
NC7 28/F R Y

Patient Subject Age/Gender Etiology CRS-R score (max 23)

PS 1

NC1 55/M hypoxic-ischemic R
NC2 29/M R N
NC3 23/M R N
NC4 36/M L N
NC5 19/F R N
NC6 18/F R T
NC7 28/F R Y

Control Subjects

Patient Subjects

Music

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<td>8-12 Hz</td>
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Group Results

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Language

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