Background

Evoked neural and hemodynamic responses to external stimuli can be used to measure local cerebral responsiveness [1]. Auditory evoked response potential (AEP) components have been shown to increase in latency with normal aging [2]. Additionally, evoked hemodynamic responses decrease in amplitude in healthy aging adults [3,4]. Cognitive functions may decline with age [5,6]. We hypothesize that limitations in cerebral vascular responsivity due to normal aging may be correlated to reduced cognitive function. In order to investigate the relationship between evoked neural and hemodynamic responses with cognitive function and age, we will combine electrophysiological and optical imaging techniques with psychological test batteries. Furthermore, we will use machine learning algorithms to predict cognitive performance and age based on cerebral vascular responsiveness.

Materials and Methods

- Participants will be
  - 12 healthy young subjects (18-25 years old)
  - 12 healthy older subjects (62-69 years old)
- We will conduct phone interviews to screen for:
  - Cognitive & neuropsychological abnormalities (Tics score <30; history of neuropsychological disorders)
  - Sleep disorders
- Testing procedures
  - Hearing loss screening
  - Questionnaires
    - DEX; Prospective and Retrospective Memory Questionnaire; Pittsburgh Sleep Quality Index
    - Neuropsychological Test Battery
    - Shipley Vocabulary; Symbol Digit Modalities Test; Brief Visuospatial Memory Test; Trail A/B; Letter Number Sequencing Test
    - Auditory Task

Electrical and Optical Brain Imaging

- We will instrument subjects with electrodes and optodes over the right auditory cortex (Figure 1)
- Light emitting diodes (LEDs) emitting 740, 810, and 880 nm light will illuminate the head
- Stimulate the right auditory cortex using 3 speaker clicks (2 ms, 3 Hz) delivered to the left ear
- Delivered at random intervals between 8-22 s
- 2 different intensities, (50 dB and 65 dB)
- Button press response to click
- Optical measurements will be used to calculate oxymoglobin (HbO2), deoxyhemoglobin (Hb), and total hemoglobin (HbT) concentration changes using the modified Beer-Lambert law [7]

Machine Learning

- Features/Attributes
  - AEP latency (ms)
  - AEP amplitude (mV)
  - Hemodynamic response amplitude (μM)
  - Hemodynamic response area (μM²)
  - Reaction time (ms)
  - DEX questionnaire (assess depressive symptoms)
  - Prospective and Retrospective memory questionnaire
  - Sleep index
  - Shipley vocabulary
  - Symbol digit modality test
  - BVMT (3 learning trials, delayed recall, copy trial, recognition test)
  - Trials A & B
  - Number letter sequencing
- Algorithms [8]
  - Decision Tree
  - Naïve Bayes
  - Support Vector Machines
- We propose to conduct multiple experiments evaluating how algorithms perform on predicting both physiological and psychological signals over varying age groups.

References

Retrieved 12/7/2010