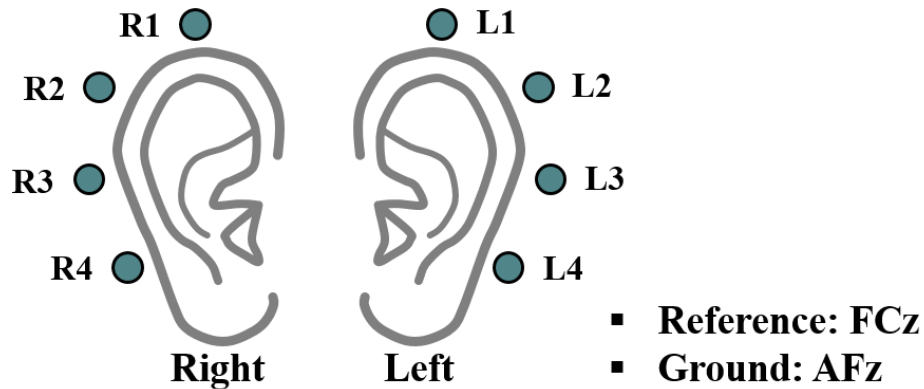


## Data Recording

Fourteen subjects (eight males and six females;  $25.57 \pm 1.70$  years) participated in this study. The experiment was conducted in a sound-proof room, and the subjects were seated in a comfortable armchair in front of a 21-inch monitor and binaural speakers. Ear-EEG was recorded using eight electrodes attached behind the ears (four electrodes for each ear), as shown in Fig 1, at a sampling rate of 1,000 Hz (actiCHamp, Brain products, GmbH Ltd., Gilching, Germany). The reference and ground electrodes were attached at Fpz and FCz position, respectively.

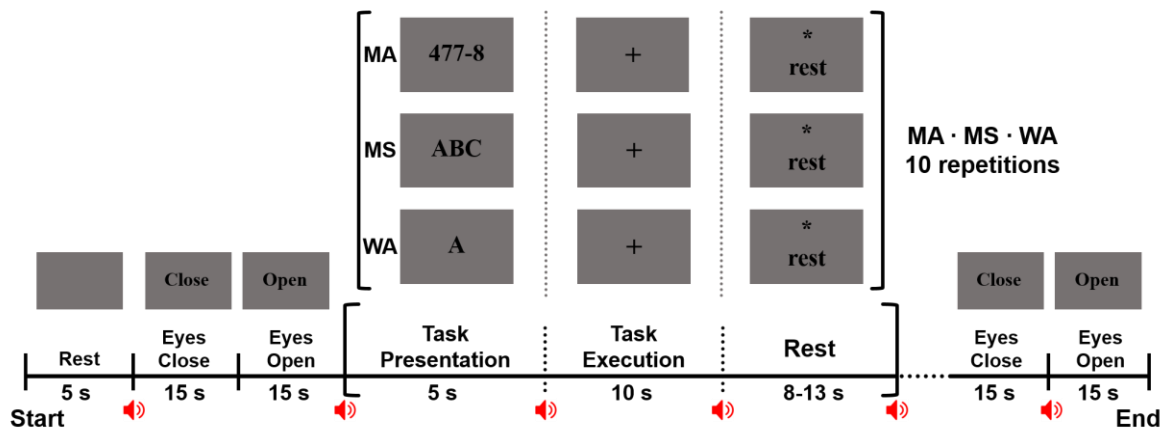


**Figure 1.** Schematic sketch of electrode positions used to record ear-EEGs.

## Experimental Paradigm

The offline experiment was performed using three cognitive tasks, defined as follows: i) mental arithmetic (MA): continuous subtractions by a single-digit number (between 5 and 9) from a random three-digit number (e.g.,  $477 - 8 = 469$ ,  $469 - 8 = 461$ , ...). ii) mental singing (MS): internally sing the English alphabet song from A to Z at a constant speed of 1 Hz. iii) word association (WA): generation as many words as possible that begin with a presented letter using subjects' native language (Korean). At the beginning of each session, a blank image was presented for 5 s, during which the subjects were asked to have a rest and prepare to perform an upcoming instruction. After the rest period, eyes-closed (EC) and eyes-open (EO) tasks were sequentially performed for 15 s. Subsequently, the three cognitive tasks were randomly performed 10 times each. A single trial was composed of a task presentation for 5 s, followed by a task execution for 10 s, and a variable rest period ranging from 8 to 13 s. During the task presentation period, either a combination of a three-digit and a one-digit

numbers for MA (e.g., 477-8), ‘ABC’ string for MS, or a single letter for WA (e.g., A) was randomly presented on the monitor. A corresponding cognitive task was performed for the following 10 s, at which time the subjects were asked to gaze at a fixation mark presented on the middle of the monitor to minimize eye movements. During the variable rest period, a string ‘REST’ and an asterisk were presented on the monitor, and subjects were asked to gaze at the asterisk to minimize eye movements without any thoughts. The three cognitive tasks were randomly presented in a session, and each session was ended with the 15-s EO and EC tasks. Each subject completed five sessions, resulting in 50 trials for each cognitive task.



**Figure 2.** Schematic diagram of the offline paradigm. At the beginning of each session, a 5 s rest period is given for task preparation. Before and after main cognitive tasks, ‘Close’ and ‘Open’ string for 15 s each are presented to indicate the task of eyes-closed (EC) and eyes-open (EO). A single trial consists of a 5 s task presentation period, 10 s task execution period, and 8 to 13 s rest period. During a task presentation, a task that the subject should perform is displayed for 5 s, e.g., 477-8 for mental arithmetic (MA), the string ‘ABC’ for internally sing the English alphabet song as a mental singing (MS), Korean syllable for generating words that begin with the suggested syllables as a word association (WA). During a task execution, subjects were asked to perform the indicated task while focusing on a black fixation cross presented on the center of a screen to minimize eye movement for 10 s. During a rest period, the string, ‘rest’ is presented with an asterisk and the subject is asked to rest without any thought and movement while staring at asterisk presented on screen.

### Data File Description

Because data analysis was performed using Matlab R2013b (MathWorks, Natick, MA, USA), we provide our dataset in the form of Matlab files (.mat). Each data folder names as subject initial (e.g., S1) has cnt and mrk files, which contain continuous time series data for all

physiological measurement (cnt) and the trigger information of the corresponding data (mrk), respectively. All data were down-sampled to 200 Hz when converting the raw data into Matlab compatible files.