EEG dataset for SSVEP using ear-EEG and scalp-EEG

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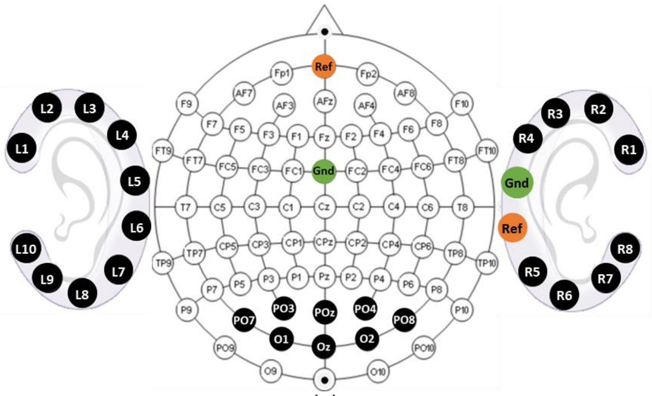
Experimental Setup

Eleven healthy subjects with normal or corrected-to-normal vision and no history of neurological disease participated in this study (age range: 25–32 years; 1 female). We simultaneously recorded EEG signals using two devices. To acquire EEG signals in the occipital area, we used a BrainAmp (Brain Products GmbH) with eight channels (PO7, PO3, POz, PO4, PO8, O1, Oz, and O2); reference and ground electrodes were placed at Fpz and FCz, respectively. Here, we call the EEG signals “scalp-EEG”. To acquire ear-EEG signals, we used the Smarting System (mBrainTrain LLC) and cEEGrid electrodes with 18 channels; reference and ground electrodes were placed in the middle of the right ear cEEgrid (for a detailed description of the system and electrode, see ref [1]). Both devices applied a sampling frequency of 500 Hz, bandpass filter at 0.3–50 Hz, and a 60 Hz notch filter. We attached two cEEGrid electrodes around both ears and then put an EEG cap on the subject’s head; Fig. 1 shows detailed channel information and the EEG device setup. To induce SSVEP signals, we designed three flickering visual stimuli on the LCD monitor (Samsung, SyncMaster 2494HM). Fig. 2(a) shows a visual stimulation; the size of the stimuli was 8 cm × 8 cm. Each stimulus had frequencies of 10, 8.57, and 7.5 Hz, which were calculated by dividing the monitor refresh rate by an integer (i.e., 60/6, 60/7, and 60/8). The visual stimuli were presented to the subjects using the Psychophysics Toolbox in MATLAB. During the data acquisition, subjects sat in a comfortable chair, and the distance between the subjects and the screen was maintained at approximately 60 cm.



(a)

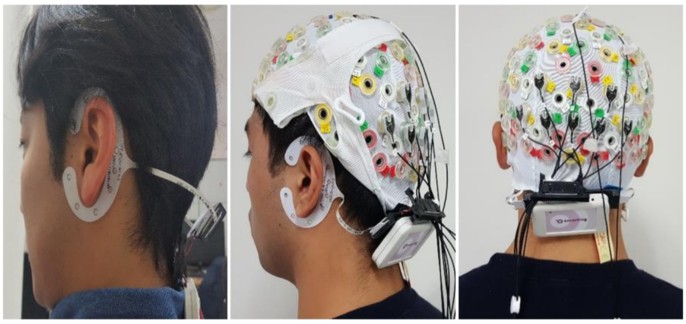

(b)

Figure 1. Channel locations of scalp-EEG and ear-EEG (a). Appearance of wearing the EEG devices (b).

Data Acquisition

We acquired three sessions of SSVEP data. In the first and second sessions (called session 1 and session 2, respectively), we used both the scalp-EEG and ear-EEG devices. In these sessions, we collected 150 trials in total (50 trials for each class). The subjects were instructed to attend, randomly, to the specific visual stimuli. Visual and auditory cues were given simultaneously. The auditory cue was provided to capture the attention and concentration of the subjects. The visual cue indicated the target class over 2 s with a yellow box on the target stimulus. The subjects were then asked to gaze at the corresponding stimulus for 6 s; during this time, all stimuli blinked simultaneously (Fig. 2(b)). In the third session (session 3), we acquired only the ear-EEG signals without using scalp-EEG devices. We collected 60 trials in total (20 trials for each class). The instructions given to the subjects were similar to those in sessions 1 and 2, except that we requested them to concentrate on the stimulus for 3 s. Note that the three sessions were acquired on different days.

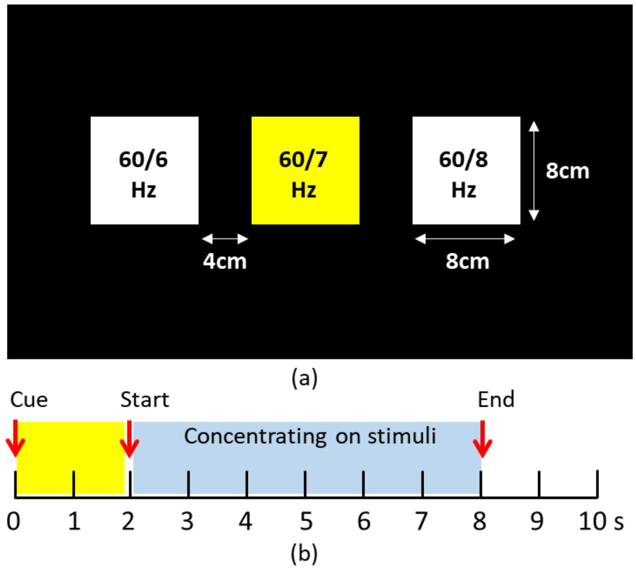


Figure 2. Size, shape, and flickering frequencies of the three visual stimuli (a). Experimental procedure for sessions 1 and 2 (b).

Data file description

We provide MATLAB Data files (33 files = 11 subjects x 3 sessions) which contain scalp-EEG and/or ear-EEG signals. Each file name indicates subject number information and session number (e.g. S02_Session3.mat is the data of subject 2 during session 3.). See details bellow.

Table 1. Description of variables

Variables	Description
cap_cnt	Scalp-EEG data structure array
ear_cnt	Ear-EEG data structure array
.x	Raw EEG signals (channel x time)
.t	Trigger time of each SSVEP trial (start time in Fig. 2(b))
.fs	Sampling frequency
.y_dec	SSVEP classes in decimal number
.y_logic	SSVEP classes in logical number
.y_class	SSVEP classes in char
.chan	Channel information

References

[1] S. Debener, R. Emkes, M. De Vos, and M. Bleichner, "Unobtrusive ambulatory EEG using a smartphone and flexible printed electrodes around the ear," Scientific Rep., vol. 5, no. 1, p. 16743, Nov. 2015.