EEG/ECG/EOG/fNIRS Data for Drowsy Driving Task

Contact: Kyungho Won (kyunghowon0712@gist.ac.kr)

Citation: Ahn, S., Nguyen, T., Jang, H., Kim, J. G., and Jun, S. C., Exploring neuro-physiological correlates of drivers' mental fatigue caused by sleep deprivation using simultaneous EEG, ECG, and fNIRS data (2016) Frontiers in Human Neuroscience.

Experimental paradigm

Eleven healthy subjects (10 males, 1 females, aged 26.6±1.4) who had valid driver's licenses participated in a custom-built virtual driving simulation task, as depicted in Figure 1. The subjects practiced repeatedly until they were familiar with the simulation system. The purposes of, and instructions for, the experiment were explained in advance, and all of the subjects signed an informed consent. Subjects received approximately $10 per h as compensation for their participation. Each subject performed simulated driving under two conditions (well-rested and sleep-deprived) on different days. Under the well-rested condition, subjects were instructed to sleep at least 7 h before the experiment, as sleeping seven or more hours is known to maintain healthy mental alertness (Kripke et al., 2002). In the sleep-deprived condition, the subjects were instructed to stay up all night in order to produce mental fatigue.

The subjects sat in a comfortable driver's seat and drove on an oval track for a minimum of 30min. The maximum driving speed was set at 100 km/h in both conditions. The steering wheel vibrated whenever the vehicle collided with a crash barrier in order to prevent the drivers from falling asleep completely. A high-definition webcam (Logitech HD Pro C920) was used to record each subject's behavior in real-time. This experiment was approved by the Institutional Review Board at the Gwangju Institute of Science and Technology (20150615-HR- 18-02-06).

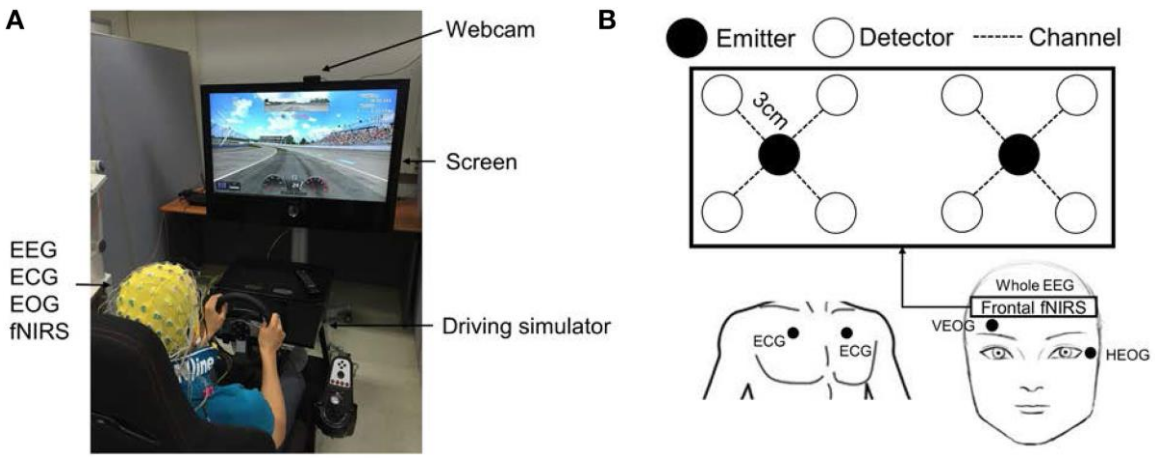

Figure 1. Experimental setup for simulated driving

Data recording

Sixty-four EEG electrodes were attached to the drivers' scalps according to the 10–20 international position system. Horizontal and vertical EOGs were used and two ECG electrodes were attached to the left/right chest (Biosemi ActiveTwo System). These data were collected at a 512Hz sampling rate using BCI2000 software (Schalk et al., 2004). Biosemi ActiView software monitored the stability and reliability of the EEG signal. After the experiment, bad channels that contained abnormal noise were identified by visual inspection and excluded from the analysis. A custom-built fNIRS system (continuous wave, 10Hz sampling rate) was used to record hemodynamic changes in the brain. This was an updated version of one described in a previous work (Kim et al., 2015). The system consists of probe and control circuits. The probe includes 2 LEDs (emitters) and 8 photodetectors (detectors). The LEDs emit near infrared (NIR) light at two wavelengths (735 and 850 nm). The emitter and four surrounding detectors were separated by 3 cm, as Homma et al. (1996) suggested that in soft tissues, NIR is able to attain a penetration depth equal to half of the emitter-detector separation. Therefore, with a 3.0 cm emitter-detector separation, our system should have been able to collect brain activity at a depth of 1.5 cm below the scalp.

Data file description

11 subjects

sb#_eeg: EEG data for drowsy condition
sg#_eeg: EEG data for normal condition

eeg.event: start and end flags
eeg.data: channel x time (64 EEG, 2 EOG, 2 ECG)
eeg.des: description
eeg.srate: sampling rate

sb#_NIRS: NIRS data for drowsy condition
sg#_NIRS: NIRS data for normal condition

handles.data: raw data (sampling rate: 10Hz)
handles.intensity: processed data using modified Beer Lambert law

*some NIRS data have multiple files due to unexpected discontinuance