Initial observations using the Emotiv Epoc

Greg Siegle, 9/2014

We have experimented with the extent to which we can use a commercial Bluetooth 14 channel EEG system (Emotiv™) for EEG and ERP analyses. We compared 8 people on an Emotiv and Biosemi Active II system. We have also scanned about 200 other people using the Emotiv and have a corpus of nearly 700 people from around the world which we've been analyzing. Based on these data here are initial observations:

Strengths:

- There are increasing numbers of publications coming out about it. Initial data from other labs suggests the Emotiv is capable of measuring event-related potentials (Badcock et al., 2013; Duvinage et al., 2013) as well as variation in EEG related to mood (Rodriguez, Rey, & Alcaniz, 2013) and cognitive tasks (Clemente, Rodriguez, Rey, & Alcaniz, 2013).
- It gets passable signals for frequencies under 45Hz and for huge smooth ERPs like slow-wave, P3, and ERN, albeit with slightly more processing than for a conventional system (e.g., regressing out movement, and more smoothing. We examined an initial sample of N=8 participants, comparing data from this system to that from our lab's standard 128 channel Biosemi Active II EEG system on a variety of cognitive and affective tasks. The expected correlation between the systems would be zero if the Emotiv did not detect a signal that the Biosemi did. Our data suggest the Emotiv system yielded reliable signals of interest. For example, for a standard eyes-open vs. eyes-closed contrast the median correlation for occipital and pariental alpha (8-12 hz) between the systems was 0.67 (max .75). For negative high arousal picture viewing vs. rest, the median correlation in frontal alpha was 0.71 (max .92) and in frontal gamma (35-45 hz) was 0.60 (max .87). For counting backwards from a large three digit number by 7 or 13, the median correlation in frontal alpha was 0.52 (max .90) and frontal beta (15-25 hz) was 0.37 (max .74). For drawing a stick figure, the median correlation across the scalp in alpha was 0.58 (max .90) and in gamma was .47 (max .86).
- Setup is fast (2-3 minutes), and data collection is trivial.
- It's fast to learn.

Uncorrectable Weaknesses:

- It is awful for stuff that takes precise timing (e.g., early ERPs). There's also slop in the serial port communication for markers further killing your ability to analyze early ERPs.
- Movement can cause bunches of artifact. So high movement situations should likely not be attempted. You can regress out movement but have to be careful with this.
- The reference is lateralized so absolute EEG asymmetry is poorly estimated (though individual differences seem to hold up) and there are too few electrodes to reliably transform the data, e.g., via current source density models.
- Having no midline electrodes is very sad.

Correctable weaknesses:

- The electrodes can slide around causing uncorrectable errors unless you fix them to the head (I use a durag).
- Stuff breaks a bunch. Have lots of extra electrodes around. The frame will get saggy and then break. I've taped plastic headbands to the inside of 5 of them and they were all better.
- The bluetooth receiver is very weak. Put it on an active USB extender and it works much better.

References:

Badcock, N. A., Mousikou, P., Mahajan, Y., de Lissa, P., Thie, J., & McArthur, G. (2013). Validation of the Emotiv EPOC((R)) EEG gaming system for measuring research quality auditory ERPs. *PeerJ, 1*, e38.

Clemente, M., Rodriguez, A., Rey, B., & Alcaniz, M. (2013). Measuring presence during the navigation in a virtual environment using EEG. *Stud Health Technol Inform, 191*, 136-140.

Duvinage, M., Castermans, T., Petieau, M., Hoellinger, T., Cheron, G., & Dutoit, T. (2013). Performance of the Emotiv Epoc headset for P300-based applications. *Biomed Eng Online, 12*, 56.

Rodriguez, A., Rey, B., & Alcaniz, M. (2013). Validation of a low-cost EEG device for mood induction studies. *Stud Health Technol Inform, 191*, 43-47.