Electro-encephalography (EEG) protocol

General information

EEG measures the electrical activity in the brain. More specifically, it measures the sum of all post-synaptic potentials of the neurones in the cerebral cortex. This signal is very weak and is therefore measured in microvolt [μV].

- Below is a brief overview of the procedure for applying and removing electrodes for EEG research. Before you start doing EEG research, however, it is important that you are trained to perform this procedure. Ensure you have mastered all the steps and that you are confident in what you are doing;
- There is a wide range of different EEG equipment. The explanation below is aimed at studies that make use of BioSemi devices with active electrodes;
- The procedure can overwhelm the participant. It is important to give the participant enough information about and during the procedure and to make sure that he/she feels at ease;
- How many loose electrodes are used and how many in the cap is dependent on the study. Consult the literature or your supervisor if you are unsure of how many electrodes to use and where to attach them.

Necessary equipment

- Electrode array;
- Loose flat electrodes;
- CMS/DRL electrodes;
- Electrode cap including chin straps;
- Electrode stickers;
- Syringe with a blunted hollow needle;
- Electrode gel (Signa gel);
- Scrub gel (NuPrep);
- Alcohol wipes;
- Cotton buds/cotton pads;
- Tape measure;
- Leukopor tape;
- Paper towels;
- Disposable gloves.

General preparation

Ensure that all the necessary equipment is to hand and that all the preparations have been made before the participant arrives.

Fill the syringe with electrode gel (Signa gel). This works best if you put the syringe on the tube of electrode gel and then squeeze the tube at the same time as pulling on the syringe. This prevents air bubbles in the syringe. Attach the needle to the syringe. Ensure that the syringe does not come into contact with the tube of electrode gel again once contact has been made with the participant.

Stick the electrode stickers onto the flat electrode in such a way that the hole in the sticker is over the brown/grey part of the electrode.

Cut up some strips (around 10) of Leukopor tape, ready for use.

Preparing the participant

Important: Always wear disposable gloves when you clean the participant's skin and stick on the electrodes. After use, always take the gloves off and dispose of them. Before the electrodes can be placed, it is important to reduce the impedance (resistance) of the skin by removing oils and dead skin cells.

Sticking loose flat electrodes

You should always start by placing the flat electrodes. Squirt a drop of electrode gel onto the conductive brown/grey part of the electrode, within the ring of the sticker. It is important here that the needle on the syringe **DOES NOT** touch the conductive part of the electrode. This can damage the electrode.

Prepare the site where you are planning to apply the flat electrode. This can be done with scrub gel or alcohol wipes. The gel should be gently rubbed over the skin with a cotton bud or a cotton wool pad. Afterwards, the skin should be dried with a clean cotton wool pad. If you use the alcohol wipe, rub the wipe gently over the skin. Take care that no alcohol or scrub gel gets into the eyes when cleaning the area around the eyes. Place the electrodes directly after cleaning the skin. Place the electrodes on the face in such a way that the leads run towards the ears, allowing you to run them over the participant's ears. Then stick a strip of Leukopor tape on the electrode to prevent it from becoming detached. Once all the loose electrodes have been applied, you can fix the leads to the participant's shoulders with some Leukopor tape. Make sure the leads are not pulled tight anywhere and that there is enough room for them.

How many flat electrodes are placed and where depends on the research project. It is usual to place four electrodes around the eyes to register eye movements including blinking. To do this, you place two electrodes above and below an eye, and two electrodes on either side of the head, next to the eyes, on the outside of the eyes. Two more electrodes can be placed behind the ears (mastoid), and their signal can be used as grounding later.

Fitting the electrode cap

After the loose, flat electrodes have been placed, you should fit the electrode cap. There are different electrode caps that differ in the number of electrodes that can be placed, as well as in size. The most commonly used caps are yellow (50 - 54cm), red (54 - 58cm) and blue (58 - 62cm). Measure the circumference of the head along the forehead and the inion. The **inion** is the protuberance at the back of the skull. Use an appropriately sized cap. If in doubt, choose a tighter electrode cap, as long as this is comfortable for the participant. Attach the chin straps to the rings of the cap. Fix the cap onto the participant's head and secure the straps. If a strap is too tight, an extra strap can be added in. Ensure that the ears stick out of the cap. Measure the distance between the inion and the nasion. The **nasion** is the depression between the eyes. Shift the cap to ensure that the Cz electrode is exactly in the centre between the inion and the nasion. Make sure that you are holding the entire cap when moving it and not just an electrode hole. Then measure the distance between the two ears and move the cap in such a way that Cz is also exactly in the middle between the ears. Finally, check that the cap is not askew.

Connecting the electrodes to BioSemi devices

Plug the loose flat electrodes into EX1 - EX8 in the BioSemi AD-box. Then plug in the CMS/DRL array. These two electrodes serve as grounding and reference point. Should the array consisting of the two electrodes CMS and DRL be used, these will need to be plugged into the BioSemi box at the front. If an electrode array that includes the CMS/DRL is used, you must plug these in to the top in A. Then plug in all the electrode arrays that you are using. If you are using 32 electrodes, you will need one array which you plug into the BioSemi box in A. With 64 electrodes, you use 2 arrays, which you plug into A and B and with 128 electrodes you use 4 arrays, which you plug into A-D. Regardless of how many electrodes you place, you should only ever attach one pair of CMS and DRL electrodes. Also, please be aware that not all configurations are suitable for measuring with 64 or 128 electrodes. Now switch on the BioSemi AD-box.

Placing the electrodes in the electrode cap

Finally, place the electrodes in the electrode cap. Before attaching an electrode to the cap, the skin underneath the electrode must be prepared. You do this using the blunted needle on the end of the syringe with the electrode gel. Stick the needle through the hole where the electrode is to be attached until you feel skin. Scrape gently across the scalp with the needle without applying pressure. It is important that you do not hurt the participant, but that you do make contact with the scalp. In doing this, you are getting the hair out of the way and reducing the impedance of the skin. This requires some practice. After scraping the skin, squirt a little gel into the hole. This should be enough to make contact between the electrode and the skin, but not so much as to cause low impedance bridges. While applying the gel, press down on the plastic around the hole to avoid applying too much gel. Then press the electrode into the hole. Repeat this process for each electrode.

Start with the CMS and DRL electrodes. These electrodes are used as grounding and reference. On the front of the BioSemi AD-box there is a blue light that needs to be on continuously if the CMS and DRL electrodes have been placed correctly. If this light is blinking, it means there is a problem with one or more electrodes. Check the CMS, DRL and loose flat electrodes. If the light is steady, connect the other electrodes one by one. If the blue light starts blinking after attaching one of the electrodes, this can mean different things. It could be that not enough gel has been used, in which case no contact can be made. Or it is possible that too much gel has been used, creating a bridge of gel which causes connectivity between two or more electrodes. So it is important to use neither too little nor too much gel. A third option is that the electrode is broken. If the light is blinking, try attaching the electrode again.

Afterwards

Remove all the electrodes from the BioSemi AD-box. Ensure that this happens in the correct way, so that the leads and connectors are not damaged. Then remove all the electrodes from the participant. You can opt to remove the cap including the electrodes from the participant's head first and remove the electrodes from the cap later. Do be careful not to break off any electrode tips! Allow the participant time to wash his or her hair and face.

Check whether the BioSemi box needs to be charged. To charge, connect the BioSemi box to the battery charger.

Cleaning

Dispose of all single use materials (tape, cotton buds, gloves etc.) in the bin. Do NOT throw the needle in the bin. This must go into a separate, dedicated sharps container.

Use warm water with detergent (Ivory detergent) and a toothbrush to wash the gel off the electrodes. Do not let the electrodes come in contact with metal. Also make sure that no water runs into the connectors. Don't forget to clean the cap thoroughly. Use a toothbrush or a small wooden stick to get all the gel out of the electrode holes. It can be useful to turn the cap inside out for this, so that you can reach easily. Make sure that you clean every hole and that all gel is removed. Remnants of dried-up gel can cause big problems when the cap is next used.

Disinfecting

Incidin Plus is used for disinfecting. Incidin Plus contains aggressive substances. It is recommended that you wear gloves, safety goggles and a lab coat while cleaning. Always read the instructions that are displayed in the labs thoroughly. Rinse the electrodes and electrode cap thoroughly with water after they have soaked in the Incidin solution for fifteen minutes. Afterwards put the clean electrodes out somewhere to dry. See also the most recent "Protocol Incidin Plus EEG Cleaning".

Literature

Band, G. P. H. (2011). Syllabus for the master course Experimentation II: Neuroscientific Research Methods. Cognitive Psychology unit, Leiden University.