EEG Cap Instructions

Supplies

You will need to have the following supplies at hand before applying the cap, all of which can be found in the "daily preparation supplies" cabinet:

- ∞ NuPrep mildly abrasive skin gel
- ∞ Black plastic cups
- ∞ Q-tips
- ∞ EC2 electrode cream
- ∞ Several syringes (no needle needed)
- ∞ A variety of tapes, found in the "adhesives" container
- ∞ HPI coils (in a rectangular box labeled "HPI")
- ∞ Impedance meter (second shelf)
- ∞ Map of electrode locations (second shelf)
- ∞ EEG cap* and at least six extra electrodes, which are normally found hanging by the sink.

* There are several different types and sizes of EEG caps. We have 70 and 128 channel caps, which come in the following sizes: 70 channel Child, pink and blue and 70 channel Adult large, Adult x-large; 128 Adult size cap.
See below for montage of standard 70 channel cap.

Positioning the Cap

The cap is labeled numerically (eg, 1-70) rather than in the 10-20 system (eg, CZ, P4, etc). However, there is a map which translates the numbers into the 10-20 system, see below for the montage.

When positioning the cap on the subject's head, you want CZ to be at the junction of halfway between the ears and halfway between the nasion and inion. There is a flexible tape measure in the cabinet marked "daily preparation supplies" that can be used for this purpose. Ideally, once CZ is moved to the right location, the cap should rest low on the forehead rather than high up at the hairline. If the cap is too small, use a larger size or place additional electrodes on the forehead in order to collect better frontal and temporal lobe data.
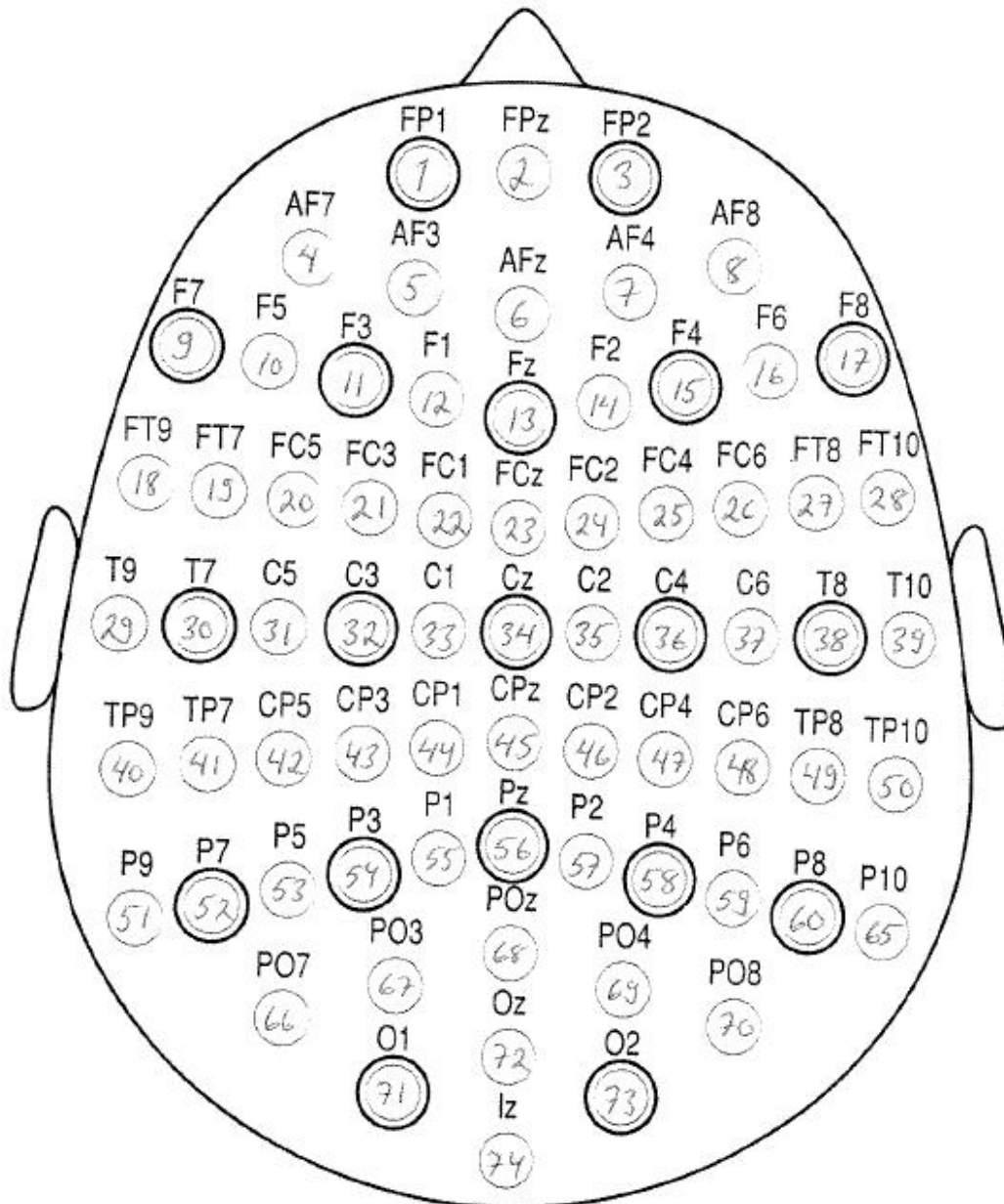
Preparing Electrodes

Once the cap is in place, you are now ready to begin preparing the electrodes with Nuprep (for skin cleansing) and EC2 cream (conductive paste to lower impedance).

- ∞ Squeeze a generous amount of Nuprep into one of the black plastic cups.
- ∞ Remove the cap from a syringe and fill about 1/3 of the way with EC2 cream.
- ∞ Using the non-cotton end of the Q-tip, gently move any hair out of the electrode location until you can see the scalp. (Be careful not to press too hard, because the wooden end can be quite uncomfortable).
- ∞ Dip the cotton end of the Q-tip into the Nuprep, and clean the scalp using a back and forth motion. It is very important that the scalp be well-cleaned during this step, so rather than go back and clean each electrode again due to bad impedances, it's better to scrub harder the first time around.

- ∞ Using the syringe filled with EC2, press the tip down to the scalp and squeeze enough paste to entirely fill the area. With your finger press the electrode down to assure the paste contacts the skin.
    - o Using too little paste can cause poor impedances, but using too much is also a risk because the paste may spread and connect two electrodes together.
- ∞ Repeat this procedure for all electrodes, generally working from front to back. Working with another lab member greatly speeds up this process!
    - o The more occipital electrodes are often harder to prepare so that they have low impedances because the cap material bunches and doesn't contact the skin.

70 Channel EEG Cap

Testing Impedances

After preparing all electrodes, you now need to test impedances. Impedance is the opposition to current flow, and thus you want impedance levels to be low. Preferably they should be under 5 k⌐, but depending on amount and type of hair, this is sometimes impossible.

- ∞ At the top of the impedance meter, there is a switch which allows you to set the "threshold" for impedances: 5, 10, 20, or 30 k⌐. Any electrodes not under this threshold will show a red light.
- ∞ Plug in the first of the EEG cap terminators (D-shaped connectors labeled in sets of 30 electrodes) to the impedance meter.
- ∞ The impedance meter is slightly confusing in that the numbers on the buttons themselves do not correspond to the numbers on our cap. Instead, look at the numbers hand-written above the buttons.
  - o The blue numbers are for channels 1-32, the red numbers are for channels 33-64, and the black numbers are for channels up to 74. (Currently the impedance meter is not marked for channels above 74.)
- ∞ To determine the impedance of a certain electrode, simply push the button for about 2 seconds and a reading will appear.
  - o To lower the impedance, simply repeat the above steps for cleaning… move the paste and hair out of the way with the non-cotton end, then clean again with Nuprep and insert more paste.
  - o Press the appropriate channel button, and see if you have improved the impedance; if not, try again.
    - If each and every electrode is high no matter what you do, then you'll simply have to increase your impedance threshold and make a note that impedances were not under 5 k⌐.
- ∞ Once you have completed checking the first of the EEG cap terminators, plug in the next one and repeat the above steps until the whole cap has been measured.

Applying Additional Electrodes

Whether using the EEG cap or not, EOG electrodes are needed to monitor eye movements: two pairs of bipolar electrodes, one horizontal and one vertical. Additionally, a reference should be placed on the nose, and a ground on the lower cheek. (If you have typically used other locations for these two electrodes, feel free to continue this method). In cases where the cap is ill-fitted on the forehead, you may also place as many extra electrodes as necessary.

- ∞ With a Q-tip and Nuprep abrasive gel, cleanse the skin where the electrodes will be placed.
- ∞ Place a generous amount of EC2 cream into the cup of the electrode, and affix it to the face with micropore (paper) tape.
- ∞ So that the electrodes do not pull or become tangled, it is a good idea to tape them all together onto the subject's left shoulder.

Additionally, you will need to place Head Position Indicator (HPI) coils on the subject's head. These can be attached directly to the EEG cap, and should be placed as far apart as possible while also remaining in locations that will fall under the sensors once the subject is pushed up into the helmet. Tape down the HPI coils firmly with both the double-sided round tape as well as the transpore (plastic) tape—they do not need any paste. It is very important that these coils do not move, so be sure that they are stable!!

Digitization

You are now ready to digitize cardinal landmarks, HPI coils, the EEG cap, and extra head points. The polhemus system, which is used for digitization, is located in a cabinet below and to the left of the PC. Instructions for connecting the whole system are as follows:

- ∞ Have the subject sit in the wooden chair
- ∞ Make sure the polhemus is on and both cabinet doors are open
- ∞ Slide the receiver into the back of the chair, with the cable pointing downwards
- ∞ Place the stylus (electronic pen) in the plastic cup attached to the chair
- ∞ Position the goggles on the subject's head, being careful not to cover up the nasion, or any electrodes and HPI coils. It is critical that the goggles are tight and do not move once digitization has begun.
- ∞ In the Acquisition program, select the last "Change" button which will take you through digitization
- ∞ At the top of the screen, hit the "Coordinate frame alignment" button; you are now ready to begin digitization
- ∞ In any order, digitize the three cardinal landmarks (nasion plus right and left pre-auricular points, see below) by pointing to each and simultaneously clicking the button on the stylus.
- ∞ It is a good idea to check that the two ear points are within a maximum (absolute value) distance of 3mm.

Right PA.

For the Nasion mark the lowest indention above the crown on the nose as shown here.

Left PA

- ∞ After the third point has been digitized, you will hear two beeps instead of one—this is simply to indicate that you are done digitizing a section. If at any point during the digitization of the different sections you hear two beeps (*before* the last point), you have accidentally pushed the stylus button twice and should start over. Instructions on how to do this are further below.
- ∞ To move on to the next section (HPI coils), there is no need to click anything else; you will simply be prompted to begin digitizing HPI.
- ∞ Digitize the four HPI coils in any order. Be *very* careful when digitizing these points, as they can come back to haunt you later if not done properly the first time!
- ∞ Next, digitize the EEG cap electrodes *in order*, starting with the reference electrode. A map of electrode locations can be found on the shelf with the impedance meter.
- ∞ If you accidentally digitize a wrong point during this phase, you do not have to completely start over.
    - ∞ In the digitization window in the green EEG area, there are two arrows. Press the left arrow once (the number to redo will now be highlighted in red) to redo the electrode that you just digitized. If you realize you made a mistake after digitizing several other points, simply press the left arrow until the number you want to redo is highlighted in red.
- ∞ Finally, you will be asked to digitize additional head points. It is a good idea to make a straight line down the forehead and nose, as the nose is easily identifiable in the subject's MRI. If the cap is high on the forehead, you should also digitize several points in this region as well.
- ∞ When finished, hold the stylus about a meter away from the subject and press the button.

If at any point you should make a mistake, you can hold the stylus away, press the stylus button, and then click on the button at the top of the section you would like to do again. This will clear any points taken in a given field, allowing you to start over. (It will not clear points in previous fields).

Connecting EEG Cap and Electrodes to the MEG

All electrodes are plugged into the MEG system on the subject's left.

- ∞ The EEG cap terminators should be plugged into the slots with corresponding numbers (eg, 1-32, 33-64, etc.).
- ∞ For EOG and other bipolar electrodes, be sure to pair them together correctly (eg, vertical with vertical and horizontal), although which goes in (+) and which goes in (-) is unimportant.

- ∞ Ground and reference are plugged into the slots labeled ground and reference, respectively.
- ∞ If you have chosen to use extra electrodes on the forehead or on the mastoids, you will need to use the "Head Box," an apparatus allowing you to plug in electrodes that are neither attached to the cap nor used as bipolar electrodes.
  - o The Head Box can be found on the third shelf of the "Daily Prep Supplies" cabinet.
  - o In the order that you digitized these extra electrodes, plug them in starting with number one on the Head Box.
  - o Plug the terminator for the Head Box into the third EEG slot marked 65-96, keeping in mind that the order for cap, EOG/bipolar electrodes, and extra electrodes will be as follows: cap 1-60, EOG/bipolar 61-64, extra 65+
    - ▪ If you are using the 128 cap, the EOG/bipolar electrodes are still 61-64 (thus the cap is numbered 1-60, then 65-128), and extra electrodes will be 129+

Acquisition Setup

Prior to preparing your subject, you should create your acquisition settings so that the proper number of EEG channels is turned on.

- ∞ In the third "change" category marked Acquisition, you will see a list of all MEG and EEG channels.
- ∞ Depending on which cap you are using, turn on the correct number of channels, as well as the desired number of bipolar channels.
  - o To change an EEG channel to a bipolar channel, right click on the number and select EOG/EKG/EMG etc from the pull-down menu. (If you forget to do this, you'll run into problems during digitization because the program will be looking for additional cap electrodes to digitize).
- ∞ Be sure to save these settings once you are done, and that each time you run this paradigm in the future you load in your saved settings… otherwise none of the EEG data will be recorded!

Cleaning Up

Because the paste used to apply the cap is very sticky, subjects will most likely need to wash their hair once the cap is removed. Soap and water should easily remove the paste, so by the sink you will find shampoo, towels, and a hair dryer. If you will not be helping subjects wash their hair, it's a good idea to warn them about the sink and its ability to soak them if they let go of the hose!

Once the session is finished, you will need to clean and disinfect the EEG cap and extra electrodes.

- ∞ With one of the toothbrushes by the sink (no soap needed), thoroughly clean each electrode on the cap so that no paste remains.
- ∞ Only *after* the cap is clean, soak the cap in the disinfectant solution for ~5 minutes.
- ∞ Rinse the cap thoroughly with water (Please don't forget this step! The solution is very potent and will irritate the skin), and hang to dry.
- ∞ HPI coils should be cleaned with an alcohol so that all tape is removed; they require no soap and water.