

Protocol CAIBCI EEG lab: step-by-step instruction

Prepare

- Turn on the lights of the BCI lab (next to the entrance door) and Lab 1 (see 'a' on Map 1).
- Turn on the 'experiment' light of the BCI lab (next to the entrance door) and Lab 1 (see 'a' on Map 1). This is a button with a little light in the middle, which will light up once it is switched on. This button controls the 'recording' lamp outside the BCI lab, indicating that an EEG recording is taking place inside the lab. When this light is on, people should be quiet when entering or passing by the lab.
- Turn on the lights in the cabin, for Lab 1 this is located on the outside of the cabin wall.
- Check the whiteboard/log located in Lab 1, there may be a message from other lab members (see 'b' on Map 1)
- Only for Lab 1: switch on the main power, this can be found in the tower between the cabin and the control room (see 'c' on Map 1). Switch on the power in the control room, for all labs this is on an extension cord behind the computers.
- Switch on the computer (at the back-left of the screen) and make sure the stimulus screen in the subject room is on.
- For experiments using sound: please make sure that the output of the general sound settings of the Mac is set to Motu.

Prepare for your specific experiment on the computer

- Switch on all monitors (one of the monitors is a mirror screen of the cabin room computer).
- Switch on the amplifier in the cabin (see 'd' on Map 1); the amplifier is attached to the chair.
- Check the battery level of the amplifier by starting the 'start_biosemi' script from Brainstream on the computer in the control room. For a 2-hour experiment, it is recommended that the battery level is above 70%. Charged batteries can be found in the control room (see 'e' for Lab 1 on Map 1 and 'f' for Lab 2 and 3 on Map 2). If the battery needs to be changed, you can unlock the battery using the black locks on the sides; make sure they are correctly locked again before using the amplifier.
- Check the walkie-talkie (baby monitor) system, make sure that it is switched on.
- Get the electrodes, cap and other supplies. Electrodes can be found in either the metal grey closet next to the cabin room in Lab 1 (see 'g' on Map 1) or the metal grey closet in the main area (next to the main entrance door). The caps can be found in between the cabin and control room of Lab 1, sizes are colour coded (yellow: small; red: medium; blue: large) and can also be found on the labels. Other supplies include: gel, electrode stickers, needles, cotton pads, alcohol, and measurement tape. These can be found on the table outside of the cabin room in Lab 1 or on the table in Lab 2/Lab 3 (see 'i' for Lab 1 on Map 1, 'j' for Lab 2 and 3 on Map 2). If supplies are missing, check the closets where the electrodes are stored, these contain many of the needed supplies. If certain supplies are running low please contact the lab manager (bci-lab@donders.ru.nl).
- Just before you start the experiment, fill the syringe with the conducting gel. To do this, you keep the syringe and the gel tube around 45 degrees and slowly squeeze the tube until there is about 2 cm of air left at the tip of the syringe. Now put in the plunger and put the needle (blunt, hollow, with purple bottom) on. (Important: Do **not** use the metal needle to apply gel to the flat electrodes.)
- Please note: the chair in the cabin of Lab 1 can be adjusted to the needs of the participant, see the manual in the cabin.

Subject arrival

- Let the subject read the information about the experiment and sign the informed consent form.
- Let the subject fill in the screening form. If the subject is suffering from any neurological disorder or is taking specific medication, they might not be a suitable participant for your experiment. If the participant is under the age of 18, they cannot take part in the experiment.
- Tell the subject that he/she can stop participation at any time.

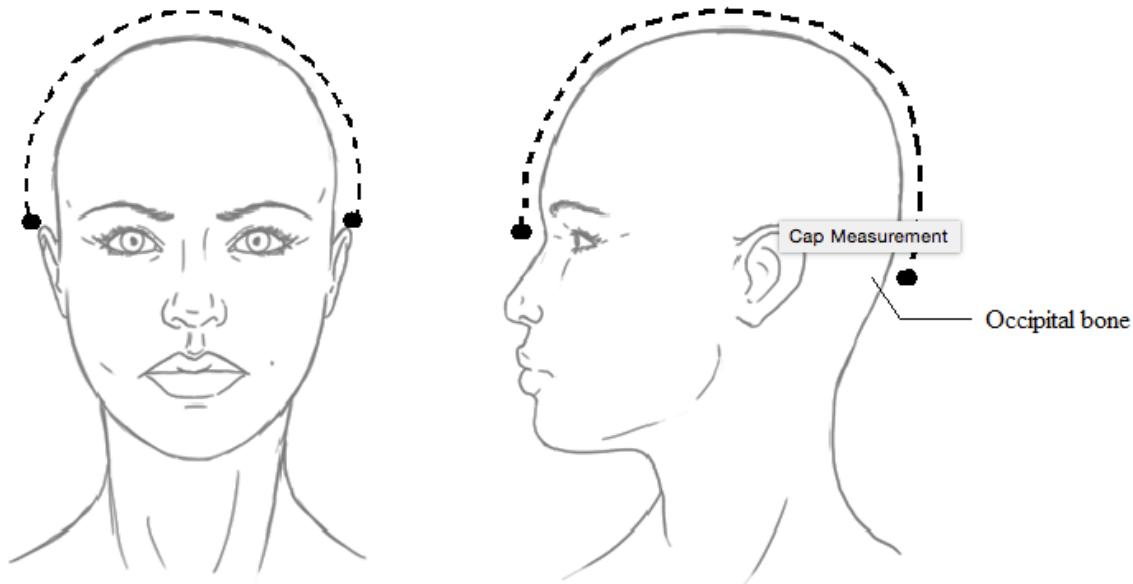
Capfitting

- Start the 'cap_montage' script from Brainstream on the computer in the control room. Indicate that you are using the 'Biosemi' device. Three windows will be opened: one with a head image and electrode positions, one with a bar plot indicating the DCC offsets per electrode and one with the raw EEG signal per channel. Note that the electrode labels in the figure with the head image switch between the 10-20 system and the electrode numbers as they are on the cap. Drag the Cap Montage windows to the cabin room screen. Usually this can be done by dragging the individual screens to the right and they will appear on the cabin room computer, you can check this on the mirror screen.
- Measure the circumference of your participants' head, and get a suitable cap (the circumferences that the caps are suitable for are indicated by their labels). The colors of the caps also indicate the size: yellow = small, red = medium, blue/purple = large. The caps can also have two colors, indicating that they are in between two sizes.
- If you use mastoid references/EXG electrodes: rub the skin of the mastoid (behind the left and/or right ear) with a cotton pad with alcohol, apply the sticker to the electrode and put some gel on the electrode. **Be careful not to touch the silvery part of the electrode with the tip of your needle!** **It is best to take off the needle to put gel on the flat electrodes.** Put the mastoid references on BEFORE you put the cap on. See figure 1 for positions. Plug the references into the amplifier.
- Put on the cap (or let the participant put it on him-/herself), stabilize with the chinstrap and add cotton pads for comfort if necessary. Check whether the cap is symmetrical. Measure ear-to-ear and front to back (nasion to inion) and make sure that Cz (A16) is in the middle crossing (see figure below).
- If you use ear plugs let the participants put them in now.
- Put gel in the electrode openings; make a circular movement to move hair out of the way while pressing the syringe to add gel. It is easiest to follow the numbers, to make sure you do not miss one. Make sure to avoid contaminating the connector plugs with gel. Also avoid connecting electrodes with gel under the cap ('gelbridges'). This could happen when the cap is too big or too much gel is used. Plug in the CMS/DRL electrodes. Make sure that the blue light on the amplifier battery is steadily on. If the blue light is blinking, the CMS/DRL electrodes are not well connected or broken.
- Plug the electrodes into the amplifier and attach the electrodes to the cap. Make sure that you connect the A side on the electrode cap (the left side of the subject's head) to the A side on the socket! Same goes for the B side (which corresponds to the right side of the subject's head). You can double-check which side should be A and B on the Cap Montage figure with the electrode positions.
- It is easiest to work from front to back, just following the numbers. Try to keep the wires as straight as possible and direct them away from the participant's face. Support the electrode cables and make sure that there is no force pulling on any of the cables. Avoid touching the metal tip of the electrodes and handle them with great care.
- If necessary, connect EOG electrodes to measure eye-movements and blinks. After capfitting, bind all wires to the chair using a Velcro strip.
- Check whether the signal quality looks good (betawaves are normally what you see). The electrodes on the head image of the Cap Montage should look green. If they look red or orange, try to fix them by unplugging the electrode, using the syringe to move hair out of the way or applying more gel if necessary (do this only once, or you risk to put too much gel), and plugging the electrode back in. If they look grey, the electrode is not connected (usually because the researcher forgot to apply (sufficient) gel). Usually the signal quality improves over time, as the gel soaks into the electrodes and the scalp. The raw EEG signals should look calm. The DC offset should be low, at least below the dotted red line in the Cap Montage figure.

Betawave example:



Cap measurement figure:



Cleaning procedure

- Prepare a washing tub with clean warm water (around 38-40 degrees Celsius) for the electrodes, towards the end of your experiment session. When the session ends, disconnect the electrodes from the amplifier by pushing down the two white handles simultaneously.
- Empty any leftover gel from the syringes into a garbage can. Throw the purple needle tips into the garbage can. Put the cap with the electrodes and the syringes in the warm water (**make sure the cable connectors stay dry!**).
- Remove the electrodes carefully by taking the body of the electrode and pull it out of the cap, **do NOT pull by the wires! Do NOT kink the wires!**
- Clean the cap. Make sure that you clean the cap while it is inside out (never brush the side with the electrode labels as you will scrub off the labels!). This is usually done using a small interdental toothbrush. Stick the brush through the electrode openings and remove the gel from the brush before pulling it back, otherwise you will put the gel back in the electrode opening. Make sure that all (I) gel is gone. It works best if you brush the cap in the water. If not all gel is removed a film of gel will form over the electrode opening. You may need to repeat the procedure.
- Clean the electrodes with warm water; most gel that is on the electrodes will quickly dissolve into the water. Usually there is no need for brushing them. They can also be cleaned further using running water (from the tap).
- If necessary, use a soft toothbrush to remove any leftover gel (avoid brushing over the sensitive tip of the electrodes!). The EXG electrodes usually require some light brushing to remove all gel. **Do not touch the electrode with metal!** Gently untangle the electrode cables, so they are ready to use for the next person.
- After cleaning, put the electrodes on a dry towel in order for them to dry quickly. The electrodes need to be stored away from light, so cover them with the same or another towel until they are completely dry, and store them in one of the (closed) metal closets while not in use.
- **Make sure the electrode tips do not touch any metals.** Residue from foreign metals can contaminate the tip, significantly impacting future signal quality.
- Clean the syringes by pulling and pushing the plunger, then take them apart to clean manually.
- If you used earplugs for the earphones, please clean them as well using water (optional) and alcohol.
- After carefully cleaning the cap, it needs to be soaked in Sekusept for 15 minutes (please wear gloves while handling Sekusept!). Mix 40 ml of Sekusept in 960 ml of water. After 15 minutes rinse the cap until no Sekusept is left and hang to dry on the faucet above the sink. Earplugs should be soaked in the Sekusept as well.
- Turn the amplifier off and exchange the battery with a fully charged one. Recharge the used battery.

- Outside Lab 1, on the wall in the main area, there is a rack on the wall where wet towels can dry. Dry and dirty towels should be placed in the hamper underneath. On Thursday afternoon (or when the hamper is full), the dirty towels should be brought up and placed in the black hamper inside the DCC labs on the ground floor. Clean towels can also be found at this location, in case the lab has run out.
- If you notice anything is running low please contact the Lab manager (bci-lab@donders.ru.nl)

Actiview

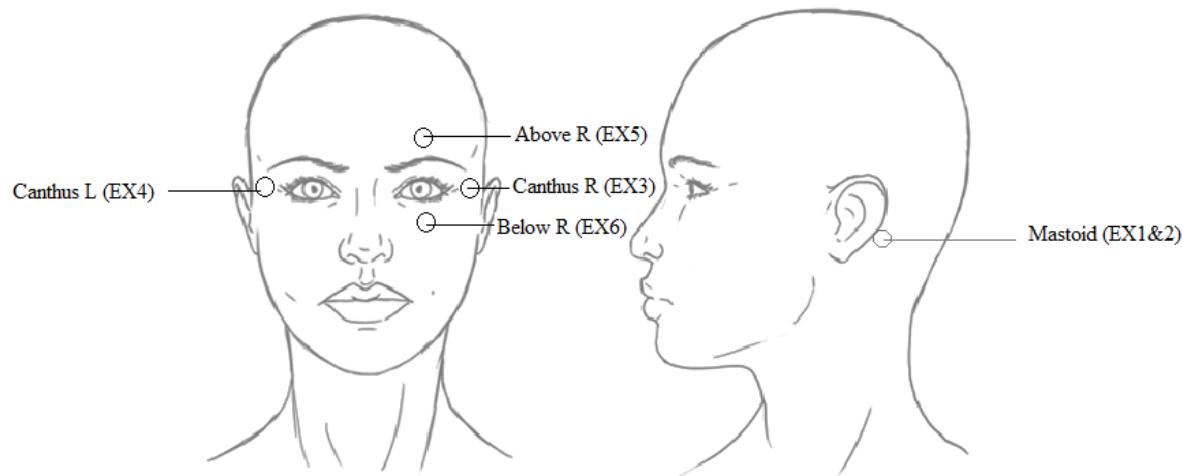
- All the controls on the left side of the display only affect the way data are displayed on screen, for example, the y-scale, low- and highpass settings. The controls on the right side of the display affect the way data are saved to disk, for example, the file limit, decimation and sample rate. So do not touch this!
- Brainstream loades a config file that sets all the controls on all tabs to the optimal setting for BCI experiments. This will overwrite earlier adjusted controls. All the controls on all the Tab-pages are saved in the .cfg file. After you have adjusted the different controls to your liking, save the .cfg file at the 'About Actiview' page (the last Tab-page). If you load your .cfg file the settings will be as you specified them, the default setting is optimal for BCI experiments
- Keyboard shortcuts:

"enter"	start acquisition
"home"	baseline reset (display only)
"arrow up/down"	higher/lower gain
"arrow left/right"	tab-page to the left/right
"page up/down"	next/previous group of channels
"F1-F8"	Insert marker on trigger channels 1 to 8

- You can also make Windows shortcuts to .cfg files on the desktop, this will open Actiview in your settings.

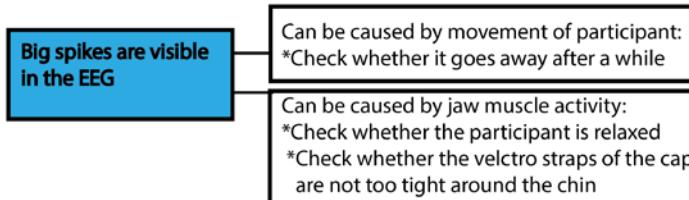
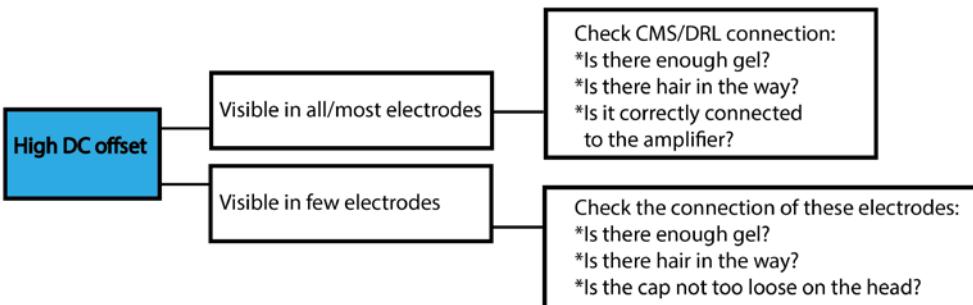
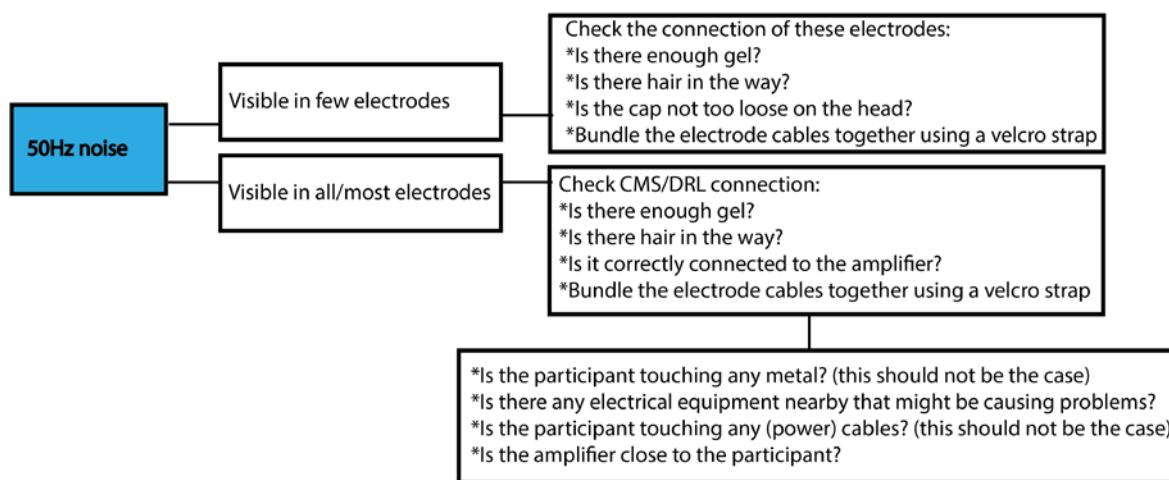
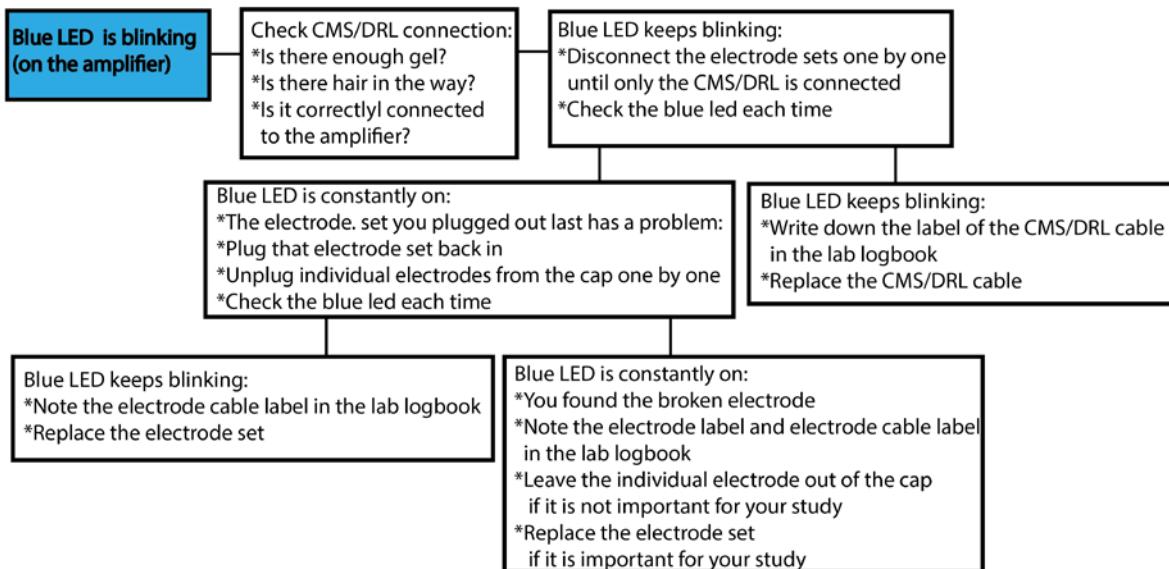
Loose electrodes

- EX1 = Right Mastoid EX2 = Left Mastoid
- EX3 = Right Canthus EX4 = Left Canthus
- EX5 = Above Right Eye EX6 = Below Right Eye



Troubleshooting

- Biosemi doesn't get input: error message after you click 'start':
- Check all cables first. Is the amplifier on? Then try to dis- and reconnect the USB input a few times. You'll get an error about a power surge at the USB port, but usually after a few (up to 10!) times it finds it again
- Signals look strange: please follow the EEG troubleshoot below.
- If the CMS/DRL light on the amplifier is constantly on but the EEG signal looks weird, one of 3 (less common) issues might be the case:
 - There is a short (caused by a gel-bridge) between the CMS and one of the measuring electrodes. This should result in a flat line for that particular channel in the raw (not re-referenced) signal display. No effect is apparent in the re-referenced signals (so turn the re-referencing off in your signal display to verify this issue).
 - There is a short (caused by a gel-bridge) between the DRL and one of the measuring electrodes, resulting in high (50Hz) interference for that particular channel in the raw (not re-referenced) signal display. No effect is apparent in the re-referenced signals (so turn the re-referencing off in your signal display to verify this issue).
 - There is a short (caused by a gel-bridge) between the CMS and DRL, resulting in high (50Hz) interference on all channels in the raw (not re-referenced) signal display, with equal amplitude for all channels.
- If your signal quality is inconsistent, there could be a kinked wire somewhere. In this case, it is best to replace the cable set that is causing problems and have it checked out by the technical support team or the lab manager. If big spikes keep appearing in the EEG data, please contact the technical support team to check out the optical transmitter of the amplifier.
- Please note any minor issues in the red Lab Logbooks that are located within each lab. Please contact the lab manager directly in case of major issues (broken amplifiers, broken electrodes, etc).
- For technical support: Philip van den Broek (p.vandenbroek@donders.ru.nl)
- Lab manager (bci-lab@donders.ru.nl).



Ethical issues

In the social faculty research using human subjects has to be approved by the ECG (ethische commissie gedragswetenschappelijk onderzoek; ethical committee behavioral scientific research). For this approval our research has to fulfill some requirements.

The 2 most important rules are:

- We must adhere to the principles of the Declaration of Helsinki
- The participant can stop participation at any moment without any further consequences.

Furthermore, there are some additional requirements for the research and the information to the subjects:

- The research is expected to result in new and important knowledge.
- The research satisfies the demands of the correct methodology.
- The research is carried out under the supervision of an experienced and skilled person.
- The research does not involve a participant that, outside the research, is in a subordinate position to the researcher (e.g., own children).
- The participant has to be informed about the purpose, nature, duration, risks and objections to the research in advance. This has to occur before the participant chooses to participate in the experiment. Also let them know that they can contact you with questions. (You could do this for example in a mail that you send to possible subjects when asking them to participate).
- If the participant chooses to take part in the experiment, make sure they are informed about the experiment before you start (see above). On the day of the experiment (or the first experiment) each participant has to sign an informed consent form. Furthermore, they have to be informed about:
 - where they can go with questions about the research (you)
 - where they can go with complaints about participation and how these will be handled (Miriam Kos)
 - That they can stop participation at any moment without any consequences, for any reason. If they are promised payment, they will get paid for the time spent.

The ethical approval number provided by the ECSW for the BCI group is **ECSW2014-3107-237**. This number is valid until 2019.

Participant interaction rules

An EEG experiment with an electrode cap on your head and electrodes on your face/body can be quite intimidating, especially if the participant is new and has never done an EEG experiment before. Therefore, there are also some (logical) rules we would like you to follow during the actual experiment:

- Explain what you are doing (especially during setting up the cap). For example, if you need to apply EOG electrodes show them on your own face where you will put them. Show them that the needle you are using is blunt and let them touch it with their finger. Encourage them to let you know immediately if they feel uncomfortable or pain.
- Never let the participant wait without telling them what is happening. So, if something is wrong with the hard/software explain it to the subject and give an estimate of how long it will take. Always try to minimize this waiting time. Anything that you can do while the experiment is running should be done then, in order to minimize the length of the experiment.
- If you want to play music during the cap setting, make sure it is not too loud. And also think about what kind of music you play: either ask your participant what he would like or play something 'easy listening'. Always make sure that the participant feels comfortable.
- Stay professional! For example, do not talk about things that you always do wrong, make sure you instill confidence.
- In keeping with the ethical considerations above, keep checking that the participant is ok, make sure you have sufficiently clarified that they can stop at any time and that you can always see/hear them, and that they are always free to ask questions etc.
- Remember that they are giving you their time (even when they're paid) and it's your responsibility that the experiment goes well.

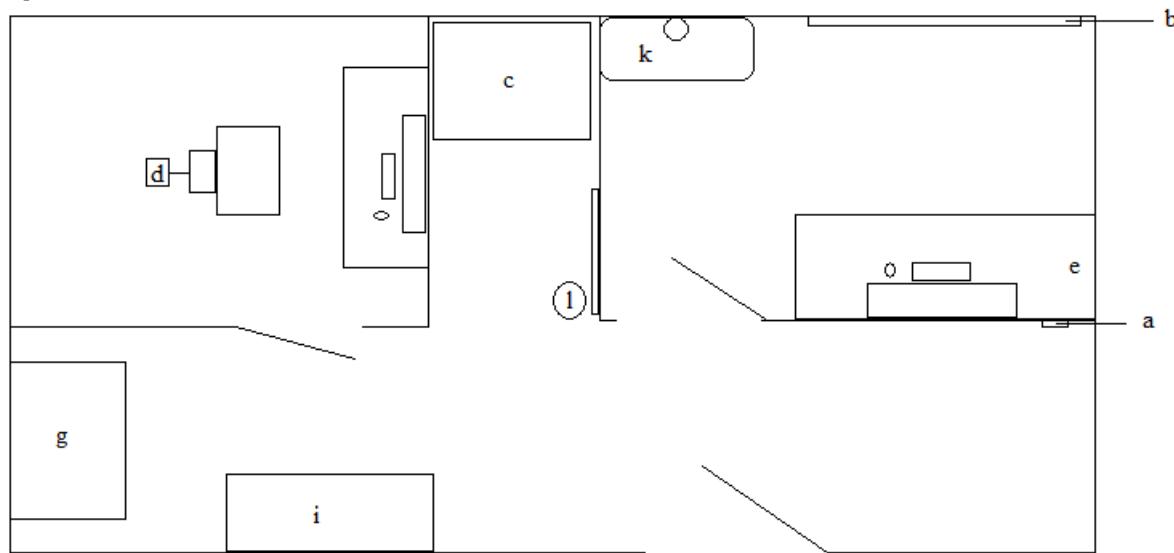
Happy participant = better chance of good data!

How to train new lab users

- All new lab users should carefully read this lab protocol (a paper copy of the lab protocol is present in each lab).
- All new lab users who intend to use the BCI lab have to be introduced to the lab by an experienced EEG researcher of the BCI lab or by the lab manager (bci-lab@donders.ru.nl).
- A minimum of 3 supervised lab usages is required before a new user is allowed to use the EEG equipment on their own. This means that if you are instructing a new user, you should teach them how to set-up and clean the EEG equipment at least 3 times.
- Please note that bachelor and master-students are never considered experienced EEG researchers for the purpose of training other new users.
- Lab users who do not comply with these criteria are not allowed to make use of the EEG labs.

Maps

Map 1:



Map 2:

