EEG Manual using BioSemi equipment

Based on various sources as well as personal experience.

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Prior to any EEG measurement

Before you start your actual measurement session (so before your first subject arrives), you check whether the following things are present:

- A fully charged BioSemi battery. If the battery has little juice left, the "lowbattery" indicator will turn on. This means you have 30 to 60 minutes ofacquisition left. If the battery is empty, the power indicator will not turnon.
- EOG (electro-oculogram) stickers
- Leukoplast tape and/or regular tape as long as its sticky enough
- Scissors
- Hair dryer
- Alcohol or neutral cleaning tonic for the skin
- Salt
- Paper tissues
- Electrode paste
- A plastic tub
- A measurement tape
- A plastic measurement cup (or something similar)
- A towel and shampoo for the subject

In case any of these items are missing you need to make sure you obtain them before your subject arrives. In case the battery is empty, you need to change the battery for a full one (see section changing/charging battery).

General

We are using a BioSemi Active 2 64 channel system. The BioSemi Active 2 has electrodes that contain a circuit (on the electrode itself) that contain an amplifier, which is the reason it is called an "active" system. In addition it contains an AD converter (the acquisition box), which is fed by a battery. The acquisition box is attached to an optical receiver that converts the optical signal to digital information. The converter box is attached to the optical receiver using an optical cable. The goal of this setup is to minimize 50Hz noise that would otherwise come from the mains. An additional goal of the battery is to prevent subjects from ever coming into contact with 220 V.

The acquisition box has connections on top and on the front panel, to connect EEG electrode bundles or EOG electrodes to. EEG electrodes are used to measure potential differences on the scalp. EOG electrodes are used to measure eye movements and/or eye blinks.

The EOG electrodes and EEG electrodes should hang from hooks that are mounted on the wall of the acquisition space. Always place the electrodes back on these hooks, and make sure the electrodes never come into contact with metal!

Figure 1

Subject selection and subject handling

Pre-Session Screening—what to look for

1. Always check with your subjects when you schedule their session whether they heave corrected vision. If they do, ask subjects to bring glasses instead of contacts if possible.Contacts are undesirable because of increased blinking. You can also ask them to bring eye drops in case they often get dry eyes. This may help to prevent blinking during the experiment.
2. Participants need to be alert for the duration of experiment, so if a subject comes across as a stony tony he is probably not suitable.
3. Screen participants for history of epilepsy, stroke, and any medications that may affect what you are studying unless these things are desired.
4. Select people without hair ornamentation, huge afro's, dreadlocks etcetera. Some people have very intricate beads, ribbon/string and other ornamentation that can prevent the EEG cap from sitting flat on their head (much less allowing gel to form a contact with their scalp).

Preparation—what you should ask your participants to do that morning

1. Hair: shampoo, comb/brush scalp for 1-2 minutes, preferably no hair care products (e.g., conditioner, gels, hair spray). You want a clean non-greasy scalp to work with. You can make a judgment call about whether they should wash their hair beforehand if they do use hair products or didn't wash hair. In most cases, it is probably not necessary.
2. Arousal: subjects should be well-rested and ready to sit still for experiment duration.
3. Subjects should use the restroom immediately before the session.

Subject handling

The goal of any experiment is to obtain clean and usable data that can be analyzed and answer the research question. Whether you succeed, depends on many factors, some of which you can also influence during measurement:

- Your subjects should be motivated
- Your subjects should understand the task
- Your subjects need to be properly attached to the equipment

Your subject is there to obtain course credits or money, not to get you clean data. This means that you will have to find the right balance between being instructing them what to do, but on the other hand remaining considerate and friendly. Finding this balance can be hard, the right balance can be different

for every subject. Never forget that subjects are very sensitive to the way you appear to them. If you are dressing sloppy and acting disinterested, chances are that your subject will not be very engaged or motivated to perform well. Moreover, most subjects will be interested in science, at least at an abstract level. You should therefore always present yourself as motivated and enthusiastic. It helps to stress how important it is for you personally that they are motivated to perform as best as they can. The experiment is important for you, and if you have the right attitude it will matter to your subject as well.

If you come across as insecure, your subject will surely develop all kinds of opinions that get in the way of correctly attaching the electrodes and getting the equipment set up. Do not show insecurity. Although it is good to be friendly and considerate, do not continuously ask whether something hurts or not (such as when you use the syringe to deposit the gel). Asking once is enough. Leave any excess insecurity you may have at the doorstep of the lab.

If you are too domineering on the other hand, your subject will also be less motivated to perform the task well. Leave any ego problems you may have at home as well ;-)

Check, while the subject is performing the task, whether your subject is performing the task as he or she should. Practice the task with your subject before you start, do not plunge right in. Provide constructive feedback to your subject if they are not doing well. You are doing well, but….

Instruct your subject abundantly, telling them what is going to happen during the experiment, what is expected from them, how long the experiment is going to take, etcetera. Make sure they read the information brochure and that they sign the informed consent.

General instruction checklist:

1. Participant should try to be relaxed.
2. No chewing of gum or other things.
3. Cell phones should be left outside the booth or completely switched off (not vibrating) if kept in the booth. No other equipment should be in the room than absolutely necessary for the experiment.
4. Minimize movement, including movement of eyes and bumping head on chair. Emphasize the importance of not moving the face or neck muscles during trials. Movement during breaks is okay.
5. Instruct your subject to blink as little as possible during the experiment!Explain that blinks are detrimental to the EEG signal and that if they do need to blink, they should either try to blink during the rest-intervals between blocks, or blink between trials and preferably not during trials.

6. Give basic task instructions. Make a note of any special circumstances of a participant on their data sheet (e.g., response mappings, color blindness, bad channels).
7. After collecting first block of data, give subject feedback on whether they are moving too much or if there are too many blinks whether they can try to reduce the blinks. Obviously they should focus more on the task than reducing blinks, so emphasize that too. Design your experiment to include automatic short breaks (10 seconds) every 2 minutes or so. This will make it easier for the subject to avoid blinking during actual trials.

You should make **a protocol document** in which you outline all the things you need to check and do while running a subject! You also need to have a **log book** in which you note any problems or noteworthy things that may occur while running a subject.

Placing the cap

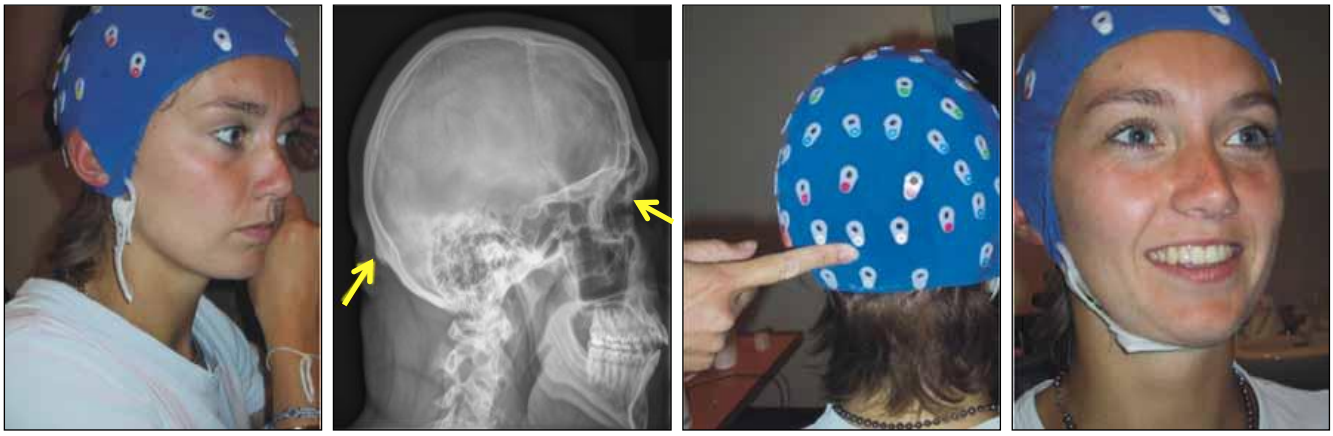
Start by placing the cap on the subjects head. There are a number of different cap sizes (not all of which are available in every lab):

- Red/yellow cap, medium/small, head circumference: 52-56 cm
- Red cap, medium, head circumference: 54-58 cm
- Red/blue cap, medium/large, head circumference: 56-60 cm
- Blue cap, large, head circumference: 58-62 cm

Use the measurement tape to have a first index of which cap to use, measuring theparticipant's head around widest part (usually through the inion). Choose cap of appropriate size for participant (size on inside tag). Use the larger cap only if the participant's head is at least 1 cm too large for the smaller cap, or if the smaller cap is unavailable for some reason (e.g., too wet). If the cap does not fit well and the electrode holders are loose against the head, use the tube gauze to fit the electrodes closely to the head. A good fit is important so that the electrodes do not move around and gel does not leak out from under the electrode holders. We are using the 10-20 system. The "10" and "20" refer to the fact that the actual distances between adjacent electrodes are either 10% or 20% of the total front–back or right–left distance of the skull.Ask participant to hold cap at front of head and pull back over the head. Make sure the cap comfortably fits.

Things to pay attention to when placing the cap:

- Make sure the ears of the subject stick out of the cap (see figure 2A)
- There are various ways of placing the cap in the 10-20 system. Iz should be at the inion (see Figure 2B). If you do not have an Iz, you can check that Oz is approximately two centimeters above the inion (see figure 2B and 2C).
- Cz should be right in the middle between the inion and the nasion (use the measurement tape).
- Fpz should be located 10% of the distance between the nasion and inion. It should be aligned mid-saggital, mid-coronal (just in front of ears). If this is difficult to achieve, that is an indication that the cap size is wrong.
- Make sure the cap is placed symmetrically, by looking at the subject from the front and confirming that midline electrodes are placed in line with nose, and that other electrodes are placed symmetrically leftwards and rightwards.
- Once the cap is placed correctly, close the chin wrap. Make sure it is not too tight, as this can be uncomfortable (2D). Check whether Oz is still placed correctly.



A **B** **C** **D**

Figure 2

Placing the electrodes

In order to be able to measure electrical signals from the skin, it is necessary to place a conducting substance between the electrodes and the skin. This substance (electrode gel) is placed using a plastic syringe.

Preparing the electrodes
To optimize your signal, put the electrode bundle in a salt solution for about 5 minutes (no longer than that). Afterwards, immediately and carefully dry the electrodes with soft tissue.

Filling the syringe
Take a new syringe for every subject. Now fill one third of the syringe using electrode gel (only use the green gel, see figure 3).

Placing the gel
Fill the electrode holders systematically. Start in the back, and move from back to front. To fill the electrode, first place the tip of the syringe on the scalp (see figure 3). Wiggle a bit through the hair, and make sure the plastic touches the scalp. Once you are sure the tip of the syringe is touching the scalp, slightly lift it off the scalp (to avoid closing off the syringe by the scalp), and slowly press the gel onto the scalp. Apply enough gel for the electrode to be able to make contact with it, but do not apply too much for this can result in an "electrode bridge" with a neighbouring electrode. You do not need to fill the electrode holder, you just need enough gel for it to make contact with the electrode. A good rule of thumb is to fill it for about 3/4. If you accidentally apply too much gel, remove any excess paste that comes out of the holder using paper tissue.

Figure 3

While you are placing the gel, it is a good idea to ask the subject whether they can actually feel the cold gel being applied to their scalp. You can ask this question for the first couple of electrodes. If they keep saying yes, you can ask them to note whether they do **not** feel the gel for any of the remaining electrodes, and ask them to tell you as soon as this occurs.

Placing the scalp electrodes

Take an electrode bundle, and place it over your shoulder. Make sure that the entire bundle does not hang from one electrode, as this can cause kinks in the wire. **Be cautious! The wire is delicate, and especially sensitive to kinks where the wire exits the electrode housing! EEG equipment is EXPENSIVE.**They seem much more sturdy than they actually are. Place the electrodes carefully, one by one, matching the name on the electrode with the name on the holder on the cap. Again, **prevent the electrode tips from touching any metal objects,** because this causes pollution of the Ag/AgCI(silver / silver chloride) pellets with "strange" metal particles, increasing noise. The electrodes are attached to the bundle in sets of 4. Place a set of 4, and then continue onto the next set. Attach the cable to the shoulder of the subject using Leukoplast tape. This ensures that the cables no longer move during the experiment, and reduces artifacts.

Placing the EOG and reference electrodes

EOG electrodes are placed using stickers around the eye. First, carefully clean the skin in the locations where you want to place the electrode using a little alcohol or cleaning tonic on some cotton. The removes grease from the skin, so the stickers will stay into place. Place a sticker on the electrodes you are going to use (see Figure 4). You can also place a second sticker next to the sticker to improve stickiness. Place some gel in the middle of the sticker on the EOG electrode, and place it on the skin (see figure 4).Attach the wire of the EOG electrode to the shoulder in the same location as the bundles using some Leukoplast tape. Repeat for all EOG electrodes.

Locations (see figure 5):

EXG1: 2cm above the right eye (aligned to center of eye)
EXG2: 2cm below the right eye (aligned to center of eye)
EXG3: 1cm right of the right eye (aligned to center of eye)
EXG4: 1cm left of the left eye (aligned to center of eye)
EXG5: On right mastoid behind right ear (reference)
EXG6: On left mastoid behind left ear (reference)

The reference electrodes are placed on the mastoids (the protruding piece of bone behind the ears, see figure 5).

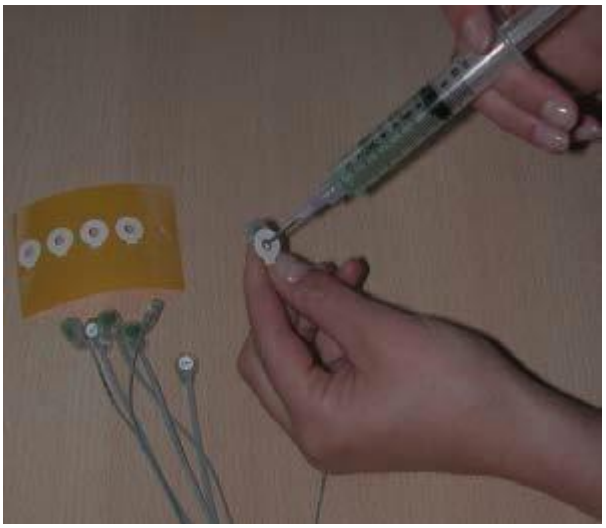


Figure 4

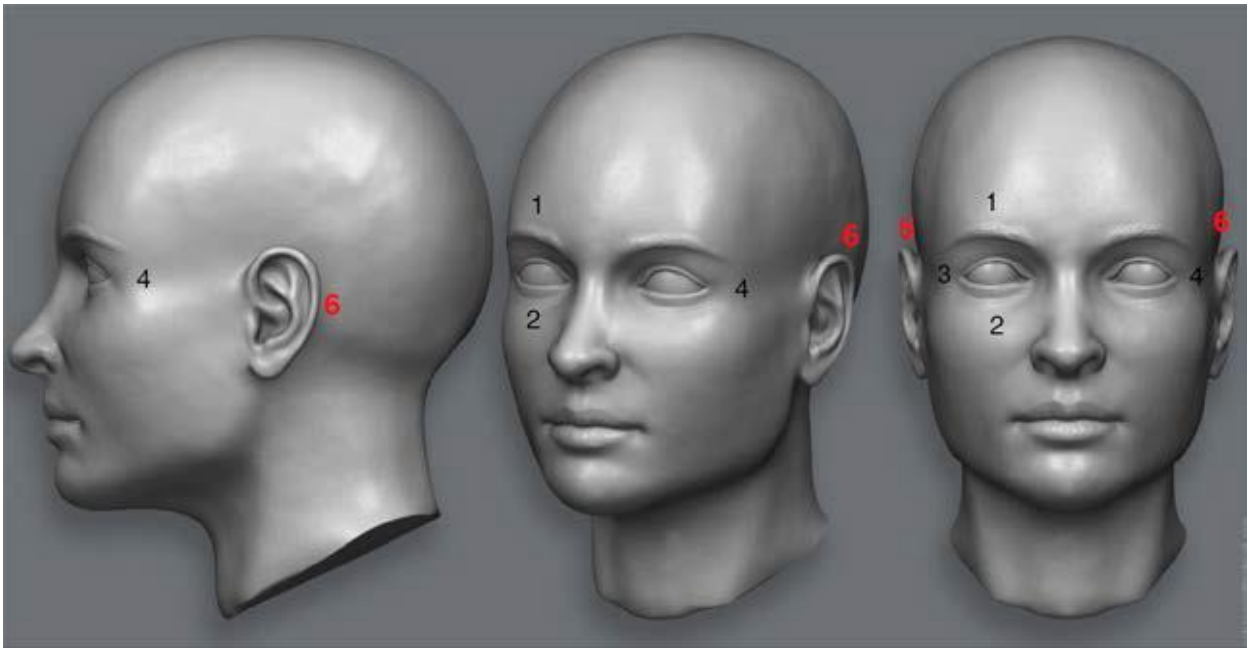


Figure 5

Attaching the electrodes to the BioSemiAD converter

First wash and dry your hands before you place the plugs into the converter. If you fail to do this, paste can get into the electrode plug or connector, which should be avoided at all costs!

The electrode bundle containing the CMS and DRL go into the first connector (A1-A32). If the electrode bundle does not contain the CMS and DRL place the electrode bundle connected to the left hemisphere to the first connector. Do this carefully (or you may break a pin), by placing the plug onto the connector, and only press down when both are level and touch everywhere. Place the second bundle (when in use) in B1-B32. See Figure 5. If you have loose CMS and DRL electrodes attach these to the biosemiAD converter.

Figure 5

Place the EOG electrodes in EXG1 to EXG6 (same order as the placement on the head, e.g. EXG1, above right eye, should be placed in the first EXG connector)

After approx. 5 minutes baseline drift and noise will have settled. After about 5 or 10 minutes, the electrode gel will have dissolved enough skin grease to be able to measure a nice signal.

Turn on the BioSemiAD converter (button at the front of the battery, see figure 6). Check whether the Common Mode (CM) in the front of the box is in range (see Figure 7). If it is, you seem to have at least connected everything correctly.

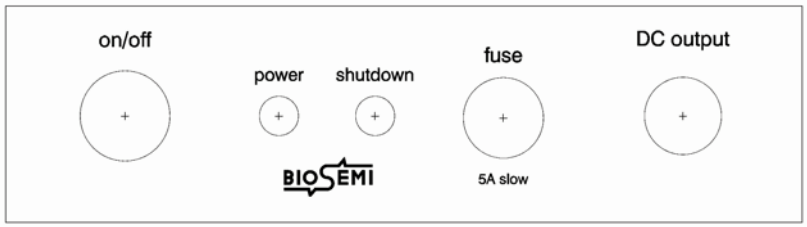


Figure 6

Common Mode in range means that the electrode signals are in range of the AD converter box. CM is in range when the lamp on the converter turns blue. If this does not happen, check whether the CMS and DRL electrodes are properly attached and contain enough gel. If this does not solve your problem, go to the *Trouble Shooting* section.

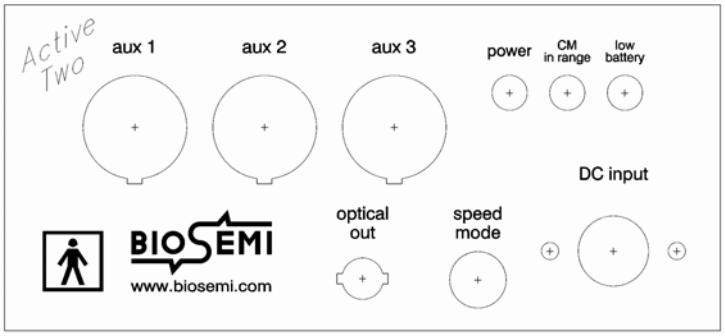


Figure 7

Recording EEG / EOG / reference electrodes

Start the BioSemi acquisition software package on the acquisition computer. You will get a layout that looks like Figure 8. Using this program, you can record the EEG signal. Settings to the left of the screen affect what you see on the screen, but do not influence what you record. Settings to the right of the screen impact how the data is being recorded.

When you press start, the program will start displaying the incoming signals. When you press stop, it naturally stops displaying.

The data are sampled at a frequency of 2048 Hz (the sampling rate). This means that the analog signal is being converted to digital 2048 times every second. This sampling rate is nice to have if you want to perform time frequency analyses. If you want to compute simple ERPs, a rate of 256 Hz is enough. You do this by changing the value of decimation to 8 (see sample rate in figure 9). Otherwise just leave it at 2048 Hz, which is your safe bet, but will cost a bit more in terms of storage. If you want to a rate of 512Hz you can set the decimation to 1/4.

- Set the scaling of the EEG channels to 500 uV /div (see Y-scaling in figure 8). Set the low pass sampling rate to 30 Hz and keep the high pass sampling rate at 0.16 Hz (these values are only used for displaying).

The software can record and display 256 channels, but you will normally not use more than 32, 64 or 128 channels. By displaying only these channels, you have an easier time determining whether everything is in order.

- Click on *Channels* and select the bundles you want to display (64 electrodes = a + B).

One cannot measure an electrical signal in absolute terms, you are always measuring a potential *difference*in comparison to a second location. This second location is called the *ground* in EEG. The BioSemi system has two ground electrodes:

- Common Mode Sense (CMS) active electrode
- Driven Right Leg (DRL) passive electrode.

These two electrodes form a feedback loop, which drives the average potential of the subject (the Common Mode voltage) as close as possible to the ADC reference voltage in the AD-box (the ADC reference can be considered as the amplifier "zero").

The CMS/DRL loop has extra functions, which are not easily realized with a single standard ground electrode that is used in other EEG setups:

1) Because of the feedback loop, the effective impedance of the DRL electrode is decreased with a factor of 100 at 50 Hz. This results in a 40 dB extra CMRR at 50 Hz when compared with using normal ground electrodes with the same impedance.
2) The DRL electrode is the only current return path between the subject and the AD-box. The return current is limited electronically at 50 uA. This protects the subject against excessive flow of currents due to amplifier and/or electrode defects. In addition, the circuit provides an indication (blue LED off) indicating whether such an error condition has occurred

With BioSemi systems, every electrode or combination of electrodes can be the "reference"; the choice is made entirely in software. When no reference is selected in software, the signals are displayed with respect to the CMS electrode. This mode does not provide the full CMRR, and should only be use as a quick check of the electrodes. Only after a reference is selected, the full 80 dB CMRR is achieved.

Usual EEG reference selections are:

- 1 electrode on top of the head (Cz).
- Average between electrodes on the two ears.
- Average between electrodes on the mastoids (preferred by us).
- Average of all connected electrodes.
- Bipolar leads between adjacent electrodes.

Subtracting the reference channel from your other channels results in the remove of substantial 50 Hz interference and other noise. Because we always analyze the data with respect to the reference, it is a good idea to visualize this also during recording (even though selecting the reference during recording does not actually change anything in terms of what is being recorded).

- Click on *Reference* and select *free choice*. Click on the channel(s) you intend to be using as a reference (e.g. EXG5 and EXG6) during analysis. From here on, the channels will be shown relative to this selected channel (although they are still being recorded relative to the CMS).

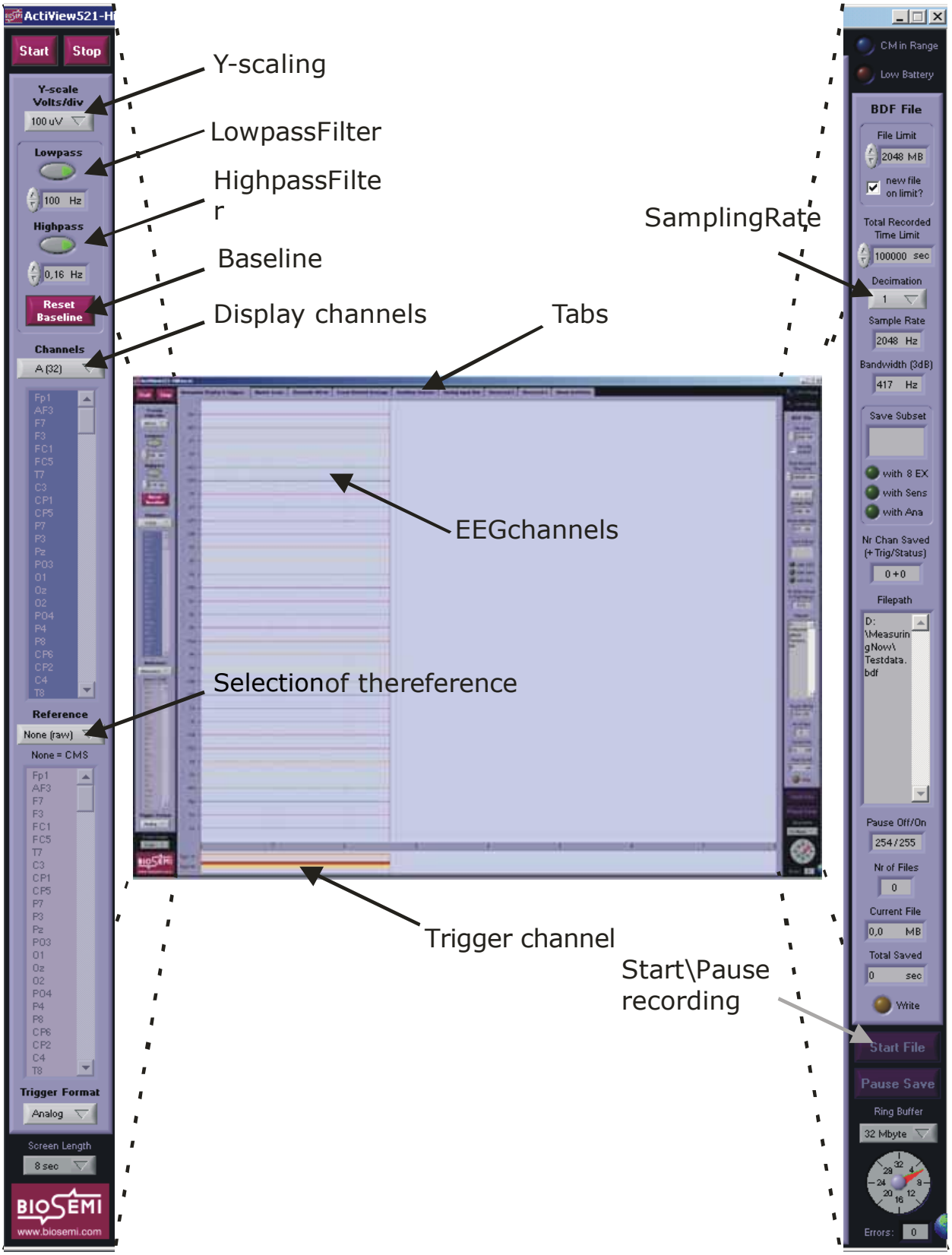

Y-scaling
LowpassFilter
HighpassFilte
r
Baseline
Display channels
Tabs
SamplingRate
EEGchannels
Selectionof thereference
Trigger channel
Start\Pause
recording
ActiView521-H
Start
Stop
Y-scale
Volts/div
100 uV
Lowpass
100 Hz
Highpass
0,16 Hz
Reset
Baseline
Channels
A (32)
Reference
None (raw)
None = CMS
Trigger Format
Analog
Screen Length
8 sec
BIOSEMI
www.biosemi.com
CM in Range
Low Battery
BDF File
File Limit
2048 MB
new file
on limit?
Total Recorded
Time Limit
100000 sec
Decimation
1
Sample Rate
2048 Hz
Bandwidth (3dB)
417 Hz
Save Subset
with 8 EX
with Sens
with Ana
Nr Chan Saved
(+Trig/Status)
0+0
Filepath
D:
\Measurin
gNow\
Testdata.
bdf
Pause Off/On
254/255
Nr of Files
0
Current File
0,0 MB
Total Saved
0 sec
Write
Start File
Pause Save
Ring Buffer
32 Mbyte
Errors:
0

Figure 9

The next step is to verify whether the electrodes are correctly making contact with the subject's scalp. If this is not the case, there may either not be enough (or any) gel in the electrode holder, or the electrode may not have been pressed into its holder properly. Remember that it may take up to 10 minutes before the gel has done its work. You can use this time to practice the task that the subject will be performing during the experiment.

- Wait 5 or 10minutes minutes while the subject is practicing.

Figure 10 shows an example of a channel of which the electrode has not been properly attached.

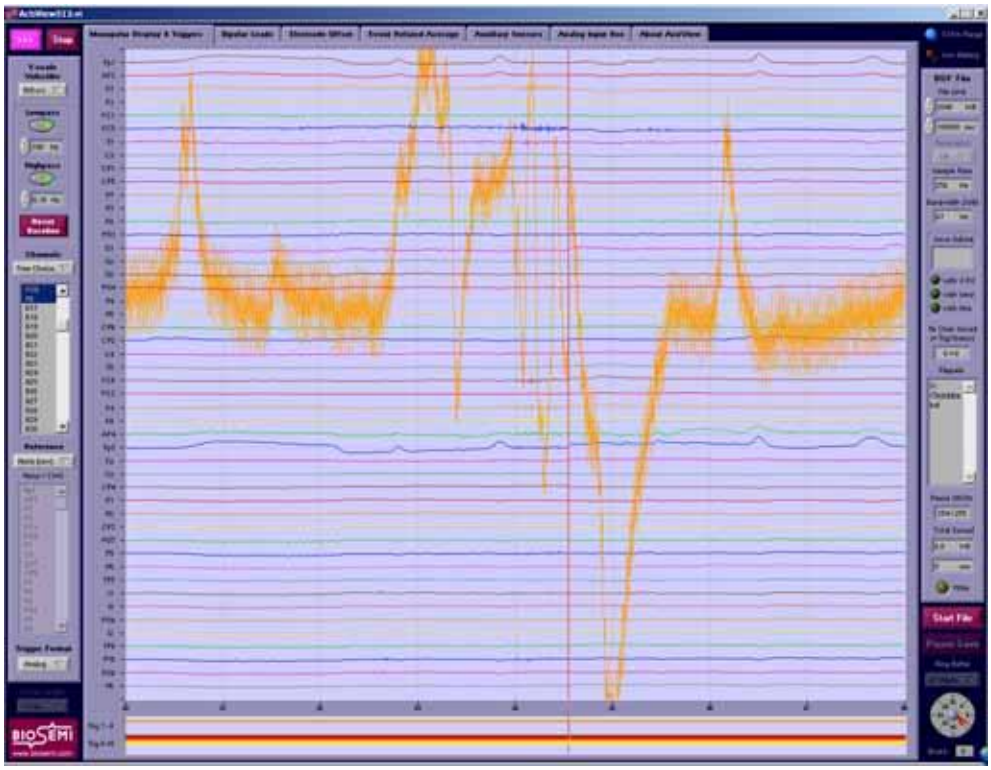


Figure 10

Check whether the electrode is properly attached to the cap. Check whether there is enough gel in the holder. If necessary, add more gel. Do this for all electrodes that have not been properly attached.

- Go to the second tab (bipolar leads) and check whether the EOG electrodes are properly registered (select left: EXG1-EXG1 and EXG3-EXG4).
- Go to the 3rd tab and check whether the electrode offset is within range. The electrode range should be between -50 and 50 uV (ideally between -10 and 10 uV). After you have clicked on the 3rd tab, you can select which channels you want to display on the left of the screen. Series A+B

contains the first 64 channels. Series G+H contains the EOG electrodes. If the electrode offset is not within the -50 +50 uV:

1. move electrode, maybe it is not placed correctly.
2. If that doesn't work, the gel might not be in contact with the skin (Move the gel inside with the syringe)
3. If it still doesn't work, add a bit more gel.
4. If still not solved the electrode might be malfunctioning. Try an external. If it works, DON'T FORGET TO NOTE THE CHANGE (e.g. A23 replaced by Ex 7). THIS IS THE LAST OPTION AND SHOULD ONLY BE DONE AS A FINAL RESORT.

- Adjust the electrode montage (the link between channels and channel names) if necessary.

We will now determine whether we are actually recording EEG. We do this by performing a couple of short tests:

- Go to the first tab and select 50 uV.
- Ask the subject to close his or her eyes. You should now see an alpha rhythm in the EEG. Ask the subject to open his or her eyes again.
- Go to the 2nd tab. Ask the subject to move his or her eyes left and right. This should be visible in the EXG1-EXG2.
- Ask the subject to make upwards and downwards eye movements and/or to blink his or her eyes a couple of times. This should be visible in the EXG3-EXG4.

If all channels are working properly, you can start recording EEG:

- Click on *Start File*.
- By law, it is not allowed to retain any personally identifiable information when recording behavioral or other data from humans. Therefore, you are not allowed to fill out any information in the **LocalSubjectIndentification** other than the sex of the subject, and whether he or she is left or right handed.
- Fill out the date under the **LocalRecordingInformation**.
- Select the electrodes you are recording from under **Save subset**(A1-A32 for 32 channels, A1-B32 for 64 channels). Also add the extra external(EXG1 – EXG4 or any other electrodes you are recording from and add Displayed sensors (these are selected when the button in front of the text is green).
- Click OK
- You now get a file dialog where you can select a location and name for your file. Use a logical naming scheme, one that you are also using for your behavioral logfiles. In my experience, the best naming scheme is the following:
  SNUMBER_TASK_DATE_BLOCK.bdf
  - Where NUMBER refers to the subject number, use leading zeroes
  - TASK refers to the task they are performing

- DATE refers to todays date (use YEARMONTHDAY, with leading zeroes)
- BLOCK refers to the block they are performing, use leading zeroes.

Example for the third subject in your experiment that is doing the first block of a 2back task on the 23rd of December 2014:
S03_2BACK_20141223_01.bdf

- **After the *Start File* procedure, the pause button is still on! You have to press *Pause* to actually start recording!** Always check whether you are actually recording anything. The total saved indicator should be increasing.
- If you have a really long experiment (+2.5h) it is better to start a new file after every block. Do this by pressing *Stop* in the upper left corner. This is the only way you can start a new file. Do not keep pausing and starting without stopping, this puts all the blocks / tasks in your experiment into one giant file!

Start the stimulus program and after you have started saving, and start the experiment!Check during the experiment whether the triggers are entering the trigger channel, and whether the subject responses are being recorded (see figure 11).

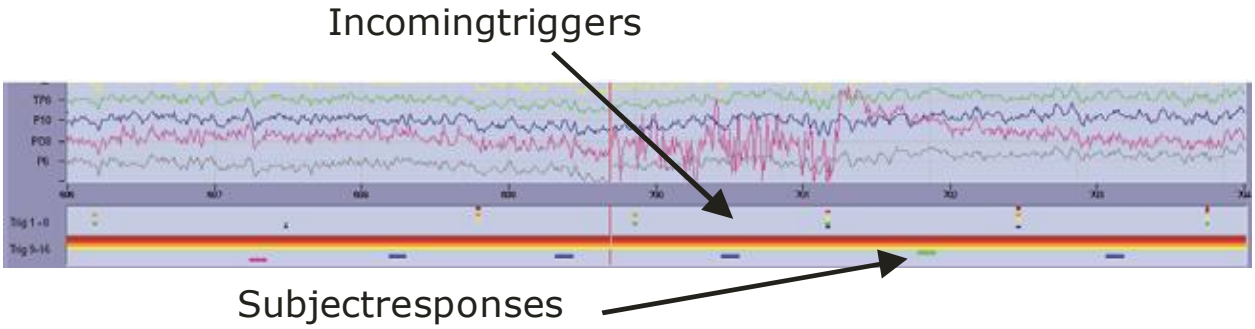


Figure11

Electrode and subject removal

After data acquisition, the electrodes need to be removed and cleaned:

- Turn off the AD box.
- Remove the EOG electrodes, carefully, especially when there is tape in the vicinity of the eyelids.
- Remove the EEG electrodes **one by one**. Importantly, **do not pull-out the electrodes at the flat cable or the wire**. Grab each electrode at its casing. Otherwise, you may damage the wire and/or the electrode. Make movements that are perpendicular to the electrode holder, and be gentle. To stress this once again: the electrodes are vulnerable and contain compressed silver / silverchloride which should not be damaged and/or polluted. Carefully hang the electrode bundles on their designated location.
- Afterwards, give the subject a towel and bring him or her to the shower room where they can wash their hair if they want to.

Cleaning

Figure 12

The electrode bundles are cleaned using warm water. An excessive cleaning process will wear and tear your electrodes more quickly. Bending the wires to much during the cleaning process will result in kinked wires to show up sooner. So, **clean the electrodes gently after use** and then let them hang to dry.

Do not let the electrodes dry without being cleaned first. When the electrodes dry up covered with gel/salt/minerals, the cleaning process will be harder and you will get kinked wires sooner due to this hard/extensive cleaning process. Disinfection is generally not necessary because active electrodes work without skin scrubbing. In case disinfection is inevitable, use only alcohol. The active electrodes are tested for compatibility with alcohol. Other disinfection agents (Metricide, Sekusept) are known to cause corrosion of the AgAgCI electrode tips, which can cause broken electrode tips when used frequently.

The silver/silver-chloride (AgAgCI) sintered electrodes behave like sponges, they absorb water and electrode gel. The deeper the water/gel has penetrated the electrode, the longer it will take afterwards for the water to vaporize. As long as your electrodes are 'wet', corrosion processes will take place. This corrosion process will in the very long run make your electrodes noisier.

Steps to follow:

- Start by cleaning the flat plastic bundle. If necessary, clean it gently using tissue, and remove the paste on the bundle. Make movements towards the electrodes (see Figure 12a). Make sure the electrodes do not touch the ground, and make especially sure that you **do not let them touch metal** as this will pollute the silver in the electrode tips with alien particles, making them noisy and ultimately useless. Use a plastic tub in which you rest the electrodes while you are cleaning the bundle.
- Next, clean the electrodes. Rinse off the gel from the electrodes using **warm tap water** (make sure to keep the connector dry). Warm water (up to 50 degrees Celsius) will dissolve the gel quickly. Only use a soft brush for removing gel residues from the electrodes if absolutely necessary, otherwise just rinse and use hands. In figure 12, the electrodes are being cleaned on a metal sink. That is the wrong way of going about it, always use a plastic (or other non-metallic) sink or tub! **Softly** dry the electrodes with **soft** tissue.
- Let them hang out to dry on their designated place (e.g. the cable-rack which was supplied together with your BioSemi system). Only use soap if water does not seem to clean the electrodes properly, **never use solvents** (e.g. acetone), acids or alkaline.
- Clean the cap using warm water. Try to prevent accidentally washing the labels from the electrodes or electrode holders (see figure 12c). You can use a small brush, sticking it through each holder to push the gel out of the holder, softly grabbing it with your hand on the other side. Alternatively you can use a toothbrush to gently clean each holder under running water. Use a system while going through all the holder locations, just as you did when you inserted the gel. Do this under a running tab, so you can wash away the gel immediately.
- When you have cleaned all the holders check that they are actually clean by holding the cap up to a light and look through each holder systematically.
- Dry the cap by hanging it to dry, alternatively if you need the cap for the next participant you can dry it using a hair dryer (see figure 12d).

Cleaning up

Clean the lab immediately after use! Paper tissues can be deposited in the trash. Stuff that is just floating around in the lab is assumed to be superfluous and will be thrown away (see figure 13 for examples of things that are considered garbage).

Figure 13

Your goal in life is to leave the lab tidier than it was when you came in!

Charging / connecting the battery

Always connect empty batteries immediately to the charger. It takes about 3 to 4 hours to fully charge a battery.

If the green LED is on, the power is of the charger is on. If the LED remains green when a battery is attached, that means the battery is already fully charged. If the yellow LED is on, the connected battery is 90% charged. If the red LED is on, the battery is still charging (see Figure 14).

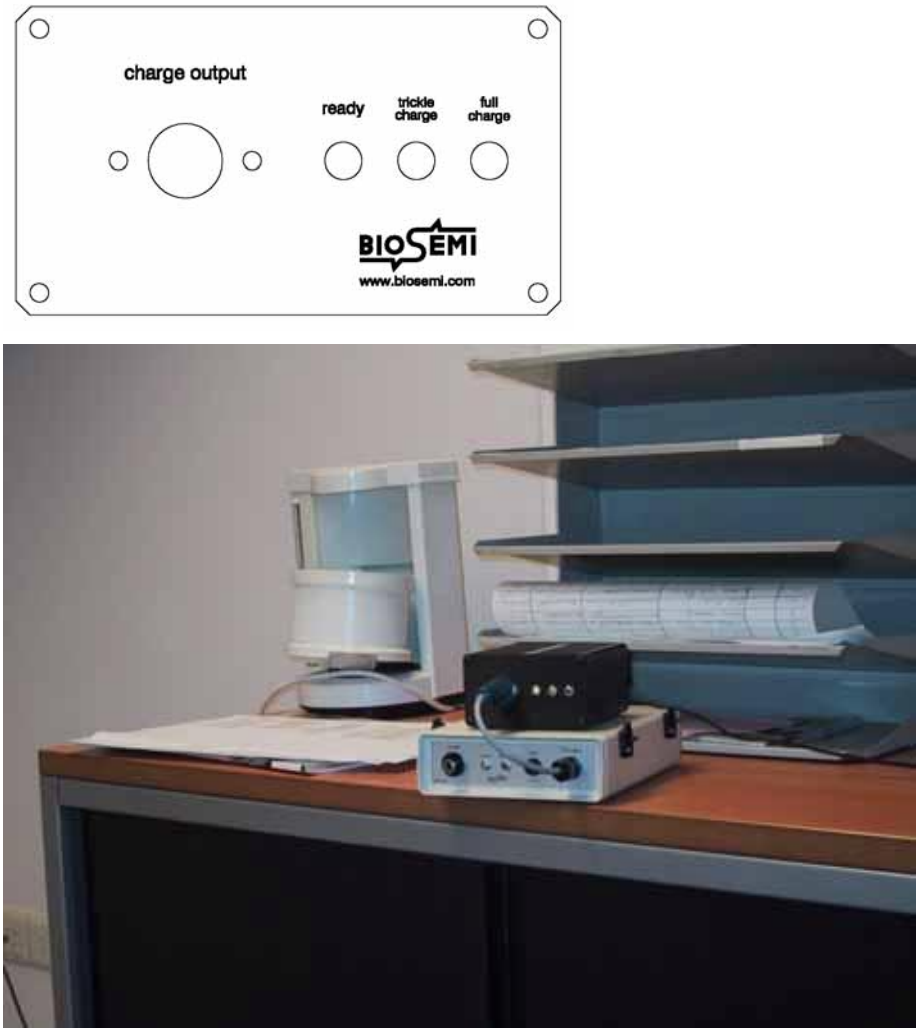


Figure 14

Troubleshooting

The LEDs on the AD converter box are all blinking
The AD converter is broken and needs to be sent in for repair.

The red LED on the battery is on
The battery needs to be charged. You may need to turn the battery on and off to reset the shutdown. If the battery is ostensibly going warm during charging (considerably more than body temperature), or if charging is taking extremely long (still no yellow light after 6 hours of charging or more), the battery needs to be replaced.

The CMS is not coming into range, not even after the usual checks

- Hold the metal part of the CMS and the DRL in your hands (make sure your fingers are moist). If the CMS turns on, that means that nothing is wrong with the CMS and DRL. Place the CMS and DRL back in their holders, and remove the other electrodes one by one. If removing an electrode results in the CMS turning on, the electrode is broken. Place tape on this electrode and continue your measurement.
- If you cannot resolve the issue, send away your subject. Fill a plastic tub with water and some salt (5 or 10 grams) and place your electrodes in the water. If the CMS turns on, you must have made a mistake during gel and/or electrode placement. Better luck next time. If this does not happen, remove all electrodes except CMS and DRL. If the light still does not turn on, the CMS or DRL is broken. Otherwise one of the other electrodes is broken. Place the electrodes in the water one by one to identify the culprit. The CMS light should turn off as the broken electrode hits the water. Check ALL electrodes, even if you have identified a broken one, because more than one may be broken. Put tape on the broken electrodes.**Soaking the electrodes in water is generally not recommended because of corrosion danger. Should you do this, limit it to 15 minutes.**

Noisy electrodes
Noisy electrodes generally mean that your electrodes have reached its endof life. You can extend the life a little bit by placing the electrodes in saltwater for about an hour before you start your measurement. This soakingprocess often removes noise. A last remedy is to use a grain 600 or higherwaterproof abrasive paper to polish the electrode tip. Use very soft circularmovements, preferably no more than 2-3 times on the same area, removing an even very thin layer across the entire surface of the tip.

Life span (Life expectancy)

Ag-AgCI sintered electrodes have a limited life span. This is caused by several processes such as corrosion, the dissolving of the Chloride in the pellets and the wearing of the pellet during the cleaning process. After approximately 200 measurements, low frequency noise will slowly increase. This is seen as baseline drift and higher offset values. Also, mechanical problems such as broken/kinked wires are inevitable after approximately 200 measurements.

If the salt water test displays increased noise and unstable offset values, it's time to replace the electrodes.

Quick reference guide:

Before the participant arrives:

1. Get the key to the lab.
2. Turn on the lights.
3. Turn on the computers (power switch for the computers located at the back corner of the room).
4. Turn on actiview on stimulus acquisition computer.
5. Start the experiment on the experiment computer.
6. Check battery, always use a fully charged battery (one battery should always be charging).
7. Prepare the things you need for measuring EEG.
    - EEG electrodes
    - EOG electrodes
    - CMS and DRL electrodes
    - Electrode caps in various sizes
    - New gel syringe
    - Electrode gel
    - EOG stickers
    - Scissors
    - Cleaning tonic for the skin
    - Salt
    - Plastic tub
    - Scissors
    - Towel and shampoo
8. Prepare as much as you can before the subject arrives.

Preparation of participant:

1. Talk to participant, if participant has participated in EEG experiment before, roughly explain what you are going to do. If participant has never participated in EEG experiment, explain extensively what he/she will have to do. Always talk to the participant while you are applying gel and electrodes and tell the participant what you are doing. Interact with the participant, make them feel comfortable

2. Get the participant to go to the toilet before anything starts.

3. If the participants skin is very oily or has makeup clean it softly with the cleaning tonic and tissues (the locations were the EOG electrodes are being placed).

4. Measure the head circumference and find correct EEG cap.

5. Place the EOG electrodes (see figure 5):

    - EXG1: 2cm above the right eye (aligned to center of eye)
    - EXG2: 2cm below the right eye (aligned to center of eye)
    - EXG3: 1cm right of the right eye (aligned to center of eye)
    - EXG4: 1cm left of the left eye (aligned to center of eye)
    - EXG5: On right mastoid behind right ear (reference)
    - EXG6: On left mastoid behind left ear (reference)

6. Place EEG cap (make sure its placed correctly and that the label is outside of the cap).

7. Fill electrode holders with gel 3/4 full.

8. Attach the electrodes to the EEG cap, one bundle at a time (also attach the CMS and DRL).

9. Put participant in the faraday cage.

10. Check that the subject is sitting at the correct distance (~75cm from screen).

11. Attach the electrode bundles to the BiosemiAD converter (CSM within range).

12. Check that the incoming data is of sufficient quality.

13. Tell the participant to try to limit his/her eye-blinking.

Start of experiment:

1. Close the faraday cage.
2. Turn of lights in the faraday cage.
3. Start the EEG data collection in actiview (make sure that it is saving data).
4. Start the experiment.
5. Check that there are incoming port codes in actiview during the experiment (**IMPORTANT**).
6. If you are measuring separate blocks, make sure that you stop and start the EEG collection after and before each block.

End of experiment:

1. Stop all data collection on the computers.
2. Turn on light in the faraday cage.
3. Turn of the BiosemiAD converter.
4. Unplug the electrode(s)(bundles) from the BiosemiAD converter.
5. Carefully take out all the electrodes from the cap (easiest if participant is still wearing the cap).
6. Remove the EEG cap.
7. Remove the EOG electrodes.
8. Give participant a towel and show him/her where to clean his/her hair.
9. Start cleaning the electrodes and the EEG cap.
10. When participant is done with cleaning up, get participant to sign/fill in payment forms.
11. Thank participant and show him/her to the exit if necessary.
12. Continue cleaning the electrodes and EEG cap.
13. Backup data (**IMPORTANT**).
14. Make sure everything is cleaned and that the lab is ready for the next user.

    Your goal in life is to leave the lab tidier than it was when you came in!

15. Turn of the computers (power switch for the computers located at the back corner of the room).
16. Turn of all the lights (including the faraday cage lights).
17. Lock the room before you leave.
18. Return the key.