# Protocol Polysemy EEG + ET experiment

**Before the experiment:**

- Turn on the lights
- Turn on the DTAL_LAB03 computer (password: john123) in Lab room 2
- Enter Lab room 1 (code: 2415)
- Close the windows and blinds
- Open the wall plugs for all computers (display PC, host PC, EEG PC)
- Make sure all computers are plugged into the charger
- Turn on the host computer
- Turn on the display computer
- Turn on the EEG computer (password: taleeg1)
- Make sure the eye tracker is in the correct position (see tape)
- Make sure the host computer is connected to the display computer over Ethernet
- Make sure the eye tracker is connected over two USB cables to the host computer
- Make sure the EEG laptop is connected to the amplifier
- Disconnect the actiPOWER from the charging cable and put it underneath the actiCHamp, then connect them in the back using the cable from the actiCHamp. You should hear a click.
- Plug the license recorder key into the EEG computer (it is in the box behind the EEG computer)
- Install the chin rest (see tape). Make sure that the white bars are used so that they don't stick out.
- Open the Experiment Builder file on the display computer. Experiment folder = “Desktop/Maria/EEG_ET_Polysemy_Even_deploy” for the even participant numbers and “Desktop/Maria/EEG_ET_Polysemy_Odd_deploy” for the odd participant numbers.

- Check the eye tracker settings on the host computer:
    - Calibration Type: Select the 9-point calibration type
    - Pacing Interval: Select 1000 delay in milliseconds between successive calibration or validation targets if automatic target detection is active
    - Disable Force Manual Accept
    - Pupil Size Data: Select Area while it is recorded in scaled camera image pixels.
    - Tracking: Select Search Limits to narrow down the area of the camera image to be searched for the pupil or CR.
    - Recording Data View: These settings control what to show on the Record screen during data output. If Record View is set to Gaze Cursor, the Host PC Record screen will display the participant's current gaze position as a cursor overlaid on a simulated display screen. If Record View is set to Plotting x, y data traces will be graphed as a function of time. Select Gaze Cursor. Select to plot the raw data.

- Prepare the EEG stuff:
    - fill two syringes with the conductive gel
    - take two needles and place them on the tips of both syringes
    - leave the syringes on the instrument table, ready to be used
    - place on the instrument table small pieces of tape, scissors, measuring tape, the conductive gel, electrode stickers, blue tissue paper, 2 plastic rings for connecting the separate electrodes (blue or green), the electrode map
    - place on the table the plastic drawer with the Caps

**Welcome:**

- Welcome the participant
- Make sure the participant's phone is off/silent without vibrate and in their bag/coat

- Ask the participant to sign the Consent form and fill out the questionnaire and payment form
- Measure the perimeter of the participant's head. Take the measuring tape and place it around the participant's head, from frontal to occipital. Use the Cap that adapts best to this measure or one cap smaller (i.e., a 55 cm will indicate that you should try to use a 54 cm Cap). Try the selected Cap on the participant's head, check if it fits well and is comfortable.
- If the selected Cap is suitable, one experimenter will place the electrodes using the head model inside Lab room 1 while the other will continue with the instructions about the questionnaire and cognitive tasks in Lab room 2.

**Cognitive tasks:**

- Open the PsychoPy file on PsychoPy interface. Task folder = "Desktop/Maria/Cognitive tasks"
- Run the PsychoPy N-back, Flanker and set-shifting tasks on the computer in Lab Room 2
- Enter the participant number (001, 002, 003, …)
- For the Flanker task, assign the 50-50 version of the task to the even participant numbers and the 92-8 to the odd participant numbers
- Each task's instructions appear on the screen automatically
- After the instructions and the practice trials, each task has the main trial
- Ask the participant if everything is clear, if they are comfortable, and if they could read the text well.
- Make sure that the mouse pointer is at the side of the screen and does not interfere with the task
- If yes, ask them to complete each task.

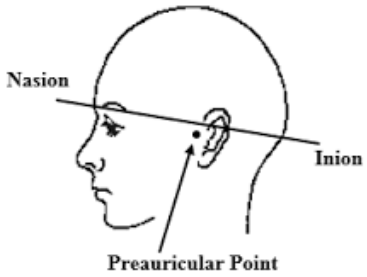
**Break before the main experiment:**

- Have a short break and then inform the participants that it's time for the main study. Ask them if they need to use the toilet before continuing, because they cannot use it once we start with the EEG.

**EEG setup:**

- It is important not to confuse the number of electrodes with the number of channels that goes from 1 to 64. The actiCAP has 32 green and 32 yellow-coloured holders. Thus, 32 electrodes from splitter box 1 must be inserted in the green holders. Similarly, 32 electrodes from the splitter box 2 must be inserted in the yellow holders of the Cap.
- After the electrodes are placed on the Cap, the experimenter needs to place the Cap in the correct position on the participants' head.
- The position of the Cap is crucial for the recordings. The location of the electrodes needs to follow the 10/20 standard:
    - Place the Cap with the GND electrode pointing to the Frontal part of the head.
    - Place the passive electrodes that are necessary to record EOG (Electro-Oculogram). We will record vertical eye movements VEOG. VEOG requires two passive electrodes, one placed at the top of the eyebrow and the other placed underneath the same eye, close to the cheek. Using wipes, clean the skin area of interest. Then, place just a bit of the conductive gel on the electrode. If necessary, lift the Cap a little to place the electrode in the right position. Stick the electrode on the required area using white tape.
    - We will also use two electrodes placed on the mastoids which will be used as references for the active electrodes in the Cap. The procedure to place these two electrodes on the mastoids is like the one explained above for passive electrodes. We will use two of the 64 active electrodes, green electrodes 10 and 21. Lift the Cap to place the electrodes on each mastoid. Before placing the electrodes, make sure the skin area which corresponds to each of the mastoids is adequately cleaned. Connect each electrode to its respective flat holders. Place one of the ring stickers on the flat holder of the electrode and stick it. Place the electrodes and holders on the mastoids and fix them with tape. The Cap will also help firmly hold these electrodes in their respective places.

- Last, we will place one passive electrode (black) on the left ear. Using wipes, clean the skin area of interest again. Then, place just a bit of the conductive gel on the electrode and stick the passive electrode on the required area using white tape.
- Once you have finished putting the VEOG and mastoid electrodes, it is time to secure the Cap and active electrodes.
- Make sure the ears appear through each of the respective holes in the Cap. Take the measuring tape and measure the distance from Nasion to Inion.




- The electrode number 32, yellow color, should be placed 10% of the distance measured from Nasion to Inion, above the Inion. Move the Cap accordingly, if necessary.
- Measure the distance from Nasion to Inion again. Without removing the tape, look at the position of the middle electrode Cz which corresponds to electrode number 24 (green colour). This electrode has to be precisely in the middle point of the distance between Nasion and Inion.
- Measure the distance from the two pre-auricular points. Once again, the Cz electrode has to be placed precisely in the middle point of this distance.
- Fill all the holders in the Cap with gel. It is recommended to start with Occipital electrodes and move towards the Frontal ones. Gently and with circular movements, scratch the scalp's surface to avoid the gel spreading over its area. Repeat the same process until you fill all the holders of the actiCAP.

- Connect the active electrodes and GND to the amplifier. Connect the GND electrode (single black electrode) to the GND input in the front part of the amplifier. Take connector 1- which corresponds to electrodes 1 to 32 connected to splitter box 1 and plug it into the first connector of the actiChamp. This is the one closest to the front part of the amplifier, just above the Aux inputs. Repeat the same with connector 2, which corresponds to electrodes 1 to 32 of splitter box 2 and plug it into the second connector of the actiChamp.
- Once you have connected the electrodes, you can proceed with the connection of VEOG electrodes to the actiChamp. Passive electrodes need to be amplified before reaching actiChamp. For this reason, passive electrodes are connected to actiChamp through a pre-amplifier BIP2Aux box, which will amplify the passive electrode signal. Take the VEOG connectors and plug one of them in the positive (+) input and the other in the negative (-) input of the BIP2Aux. Plug the black electrode connected to the earlobe in the middle. Then plug the output of this BIP2Aux box into the Aux1 input of the actiChamp.
- Start Brain Vision Recorder software. Start and log into the recorder laptop that will be used to record and save the EEG data. Make sure the USB key license of the software Brain Vision Recorder is plugged into the laptop. The reference number UR12415 appears written on one side of the USB recorder Key.
- Start Brain Vision Recorder, which you can find on the upper left corner of the desktop.
- Create a New Workspace. Choose a name and the folder in which to save your EEG recordings. Once you enter the name, press next and go to Amplifier Settings. First, press Scan for Amplifier; this will detect the amplifier that is connected to the laptop. Enter the 65 as the total number of channels that you will use for your recordings and 64 as reference.
- Choose 500 Hz as a sampling rate with which you want the signal to be digitized.
- Enable Active Shielding: tick this option so that most of the environmental noise will be cancelled
- Channel Settings: you need to activate each of the Aux channels by clicking on the box next to their Phys, Channel number, which is called Diff.Unit.

- Electrode Position File: it is essential that every time you create a new workspace, you load the ".bvef" file, which contains the information of the location of all channels as well as electrode topography. When you click Use Electrode Position File, a new window will open. Click "Browse" and search for the file called "CMA_64_NO_REF.bvef" which is saved on the desktop in a folder with the name "acticCap Electrodes". Then click "Import amplifier channel table". Tick on "Read Positions from Electrode Position File". Close the window, click ok and go back to the Amplifier Settings screen. Once you have completed this page of the settings, press next to go to "Software Filters" and click ok.
- Enable Filters: do not filter the frequencies, click next and then click finish
- Start Monitoring: Once the workspace is set with an amplifier, sampling rate, channels, and filters, it is time to have a look at the signals that each of the electrodes are capturing. Press the first icon on the upper left corner of the recorder window called Start Monitoring. You will immediately start viewing the brain signals captured by each electrode.
- Check Impedances: click the icon with a box in the toolbar. A new window will open, which will show a topographic distribution of the 64 electrodes. A colour bar next to the map will help you know the impedances registered at each electrode. Green indicates that the impedance level is optimal (Z<25KOhms). Amber indicates that the impedance level is acceptable(Z<60KOhms). Red indicates that impedance level is bad (Z>60 KOhms). Make sure that the GRD electrode has an optimal impedance as this will affect the impedance measures of all the other electrodes.
- In order to improve the level of impedances of the amber or red electrodes, introduce the syringe with the needle into the cavity that you will find on each electrode. Gently and slowly move the needle in circles to help spread the gel already on the scalp. If the LED of the electrode does not change colour, add a bit more gel towards that particular electrode.
- Ask the participant to rest his/her chin in the chin rest and look at the display screen

**Explain the main experiment:**

- Explain the main task: They will read sentences and answer questions about those sentences
- Tell the participant that we are *not* making movie recordings; we are just tracking what they are looking at and how their brain processes it. Tell them that to do this well, they should try not to move and not blink during a trial.
- They will read sentences and answer questions about them with a yes/no button press. During the exclamation marks (!!!), they can blink.
- The experiment has two parts. After approximately 17 mins they can have a break before the second part is started.
- Before the main experiment, they will see a written explanation and do some practice trials.
- All responses can be given with the **j** or **f** keyboard button.

**Run the main experiment:**

- Double click the file **EEG_ET_Polysemy_Even_deploy** for the even participant numbers and **EEG_ET_Polysemy_Odd_deploy** for the odd participant numbers
- Enter "polym" for polysemy monolinguals, followed by the participant number (001, 002, 003 ,…)
- Instruct participants to read the instructions until the eye tracker is set up

**Eye tracker setup (will start after instructions):**

- Tracking mode: Select the tracking mode (pupil-only vs pupil-CR) for recording. Choose Pupil-CR because Pupil-only tracking requires complete head immobilization for high accuracy.
- Sample Rate: Select a 1000 Hz sampling rate for recording.
- Pupil Tracking: Select the method used to fit the pupil and determine pupil position. Select the Centroid model.
- Camera Position: Select left position
- Eye(s) to Track: Select the monocular tracking.
- Select the right eye with the cursor on the host computer

- Focus using the focus ring on the eye tracker. The eye is in focus when the cornea reflection (white circle) is smallest. You can see the video stream on the display computer if you press 'enter'.
- Then adjust the thresholds for the pupil and the CR. You can do this first by pressing 'auto'. You can de- and increase the threshold with the arrows. The dark blue part on the pupil needs to be as big as possible, without colouring in too much of the rest of the face. Also, the light blue part on the cornea should be as big as possible without colouring in too much of the rest of the face.
- In general, after threshold adjustment, pupil thresholds should be **between 75 and 115,** and corneal thresholds should **not exceed 240**. If the pupil threshold is too low, try increasing the illumination output or decreasing the eye-camera distance. If the pupil threshold or corneal thresholds are too high, try reducing the illuminator output
- Instruct the participant to look at the dot
- Start the calibration
- When the calibration is finished, click Accept
- Start the validation. Press space when the participant looks at the dot and their gaze is stable
- Check at the bottom of the screen whether the validation is good. If not, redo the calibration and the validation.
- Instruct the participant to continue with the practice trials
- After the practice trials, ask the participant if they understood the task and continue with another calibration and validation before the main trials
- Before every trial, you have to press the space bar on the host computer to continue when the participant looks at the dot (drift correction)
- If the drift correction does not work, click 'Abort' and recalibrate and revalidate. Alternatively, you can go back to the drift correction by pressing 'ESC' on the display computer.
- If you are disturbed for some reason, the program will wait automatically at the drift correction, and from there, you can recalibrate and revalidate.

**Start the EEG recording:**

- After the main trial's instructions, start the recording by pressing the play button on the EEG laptop
- Click the left mouse button to let the participant start the experiment

**Break:**

- A break will be given automatically by the experiment. Make sure they actually take a break (~1 min) to rest their eyes and blink. They should not move their head too much though
- Click the left mouse button to let the participant continue with the experiment
- Continue with the experiment after recalibrating and revalidating

**After the experiment:**

- Remove the Cap and put it in the bucket carefully
- Ask the participant to complete the payment form
- Ask if they noticed the goal of the main experiment
- Give them the debriefing form
- Thank the participant and let them wash up, give them a towel and shampoo to use. Show them to the washroom
- The participant can knock on the door when they are done, or you can keep the door to the toilets open with a big book
- Make an .asc file by running convert edf
- Back up the data: on the display computer, open the Results folder → Back up the .asc and .edf files on a USB stick
- Back up the data: on the EEG computer → Back up the output files on a USB stick
- Back up the data: in Lab room 2 →Back up three excel files on a USB stick
- Turn off the host, EEG, and display computers and Lab room 2 computer
- Turn off the wall sockets for the host, EEG and display computer
- Place the Analyzer license key to its box behind the EEG computer
- Return actiPOWER to the corner of the table and plug it into the charger

- Clean the chinrest with paper and rubbing alcohol
- Clean the electrodes and the Cap in the washroom with a toothbrush. Be careful not to let the electrical connections get wet!
- Hang the electrodes back and leave the Cap to dry on top of the filing cabinet

**Notes:**

- If a participant has glasses, they can participate as long as the eye is completely visible. Contacts are also allowed. Too much mascara might interfere with the eye tracking measurement. During the calibration, you will find this out; you could then ask the participant to remove the mascara.

**Protocol checklist Polysemy study (monolinguals)**

Date _____

Participant number (ddd) _____ (participant code = “polym” + participant number)

Experimenter _____

**1. Preparation**

❑ Prepare and sign forms, questionnaires

❑ Turn on computers (3x), make sure they are on their chargers, prep. experiment code + EEG dongle

❑ Prepare EEG equipment: 2 syringes, 2 needles, gel, tape, scissors, measuring tape, electrode stickers, blue tissue paper, 2 plastic rings, electrode map, caps

❑ Prepare cognitive tasks

**2. Welcome + Cognitive tasks**

❑ Measure head

❑ Consent form, questionnaires, payment form

❑ N-back

❑ Flanker (50-50 for the even participant numbers, 92-8 for the odd participant numbers)

❑ Set-shifting

**– Break –** Ask if participant needs to use the toilet before the EEG setup

**3. EEG prep.**

❑ Explain EEG setup

❑ EEG cap + ground electrode

❑ Green electrodes 10 and 21 on the mastoids

❑ 2 separate electrodes above and below the left eye (VEOG), 1 black ground on the earlobe

❑ Create a new Workspace

❑ Enter 65 channels and 64 as reference

❑ Choose 500 Hz as sampling rate

❑ Check Impedances

**4. Main experiment**

❏ Adjust seat, explain buttons

❏ Explain experiment + break

❏ Run experiment

❏ Eye-tracking: pupil thresholds **75-115,** corneal thresholds <**240**

❏ Start recording EEG (by pressing the play button and giving a name to the recording file) before the main part of the experiment

**5. Finish**

❏ Debrief participant

❏ Give participant towel + shampoo, show them to shower

❏ Complete payment form, put all forms in 'data' binder

❏ Clean EEG equipment, clean headrest, and all rooms

❏ Back up the data: edf, asc, EEG output, cognitive task output

Comments:_____

_____

_____

_____