Computational Neurology Lab – Eyelink Experiments

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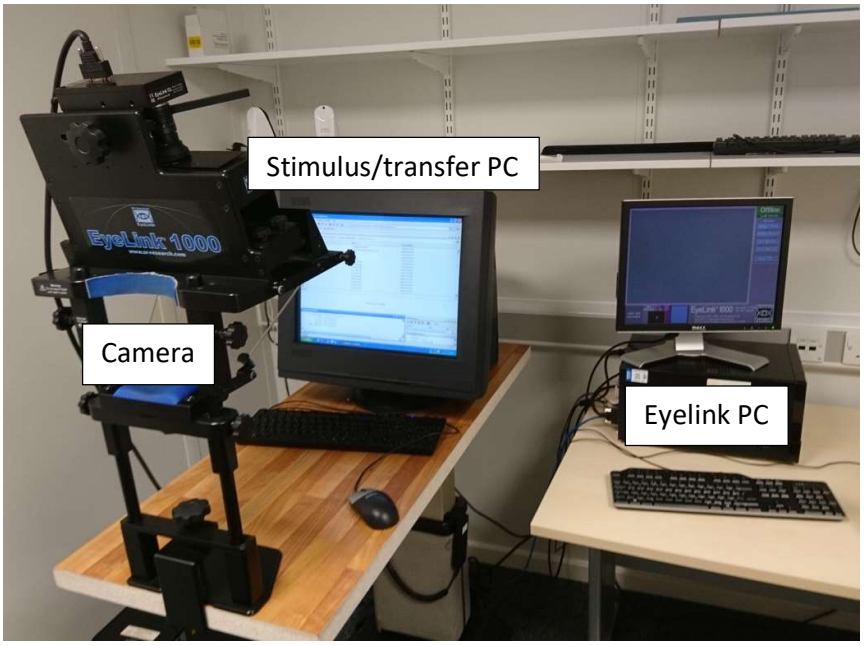
Initial set up

There are two computers – a transfer/stimulus PC (for displaying the experiment and storing the data), and the Eyelink PC.



The eye tracking camera will be in front of the stimulus PC.
The eye tracking camera will need to be calibrated to a particular person at a particular time, as it translates the real time position of the eye to a representation on the computers. Note that you are only tracking one eye most of the time.
Eye movements are ballistic – they are likely to go from point to point. It is unlikely that your eyes are moving by fractions of degrees every millisecond. Please bear this in mind when considering your eye tracking data online and offline.
The Eyelink is an infrared camera. It differentiates dark/light colours. The pupil will be dark. Any obstruction to this dark circle, anything dark around it, will confuse the camera.

You can expect 2 files to be created from an eye tracking experiment

- A .mat file within which you save the results of the experiment (e.g. reaction time, whether the participant made a correct choice etc). This is created and stored on the stimulus PC
- A .edf file which has the position of the eye and pupil diameter calculated at every millisecond. This is created and stored on the Eyelink PC, but transferred to the stimulus PC (automatically at the end of most experiments). The stimulus PC has a way to obtain any lost timestamped edf file from the Eyelink PC (start, all programs, SR research, utilities, *eyelink_getfile*). This edf file will make no sense when opened in a text editor (has to be read in Hex). A later section will discuss the conversion of this file to something useful.

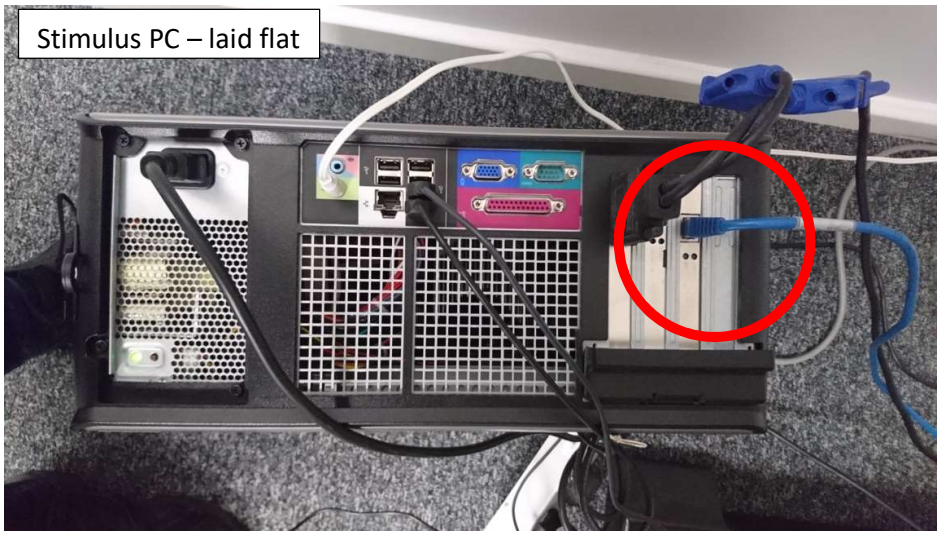
Now that you are familiar with the data types and the computers, please read the instructions for the set up of an experiment.

The two computers should be connected by a LAN cable in a specific way.

Eyelink PC

Stimulus PC – stood up

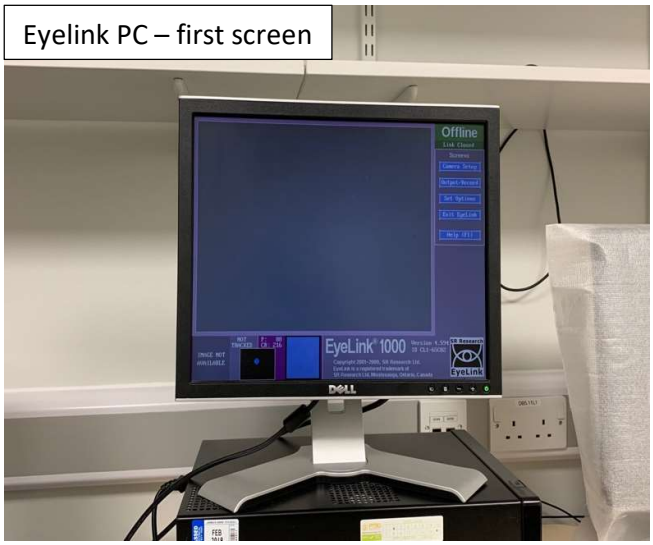
Stimulus PC – laid flat



Setting up stimulus PC

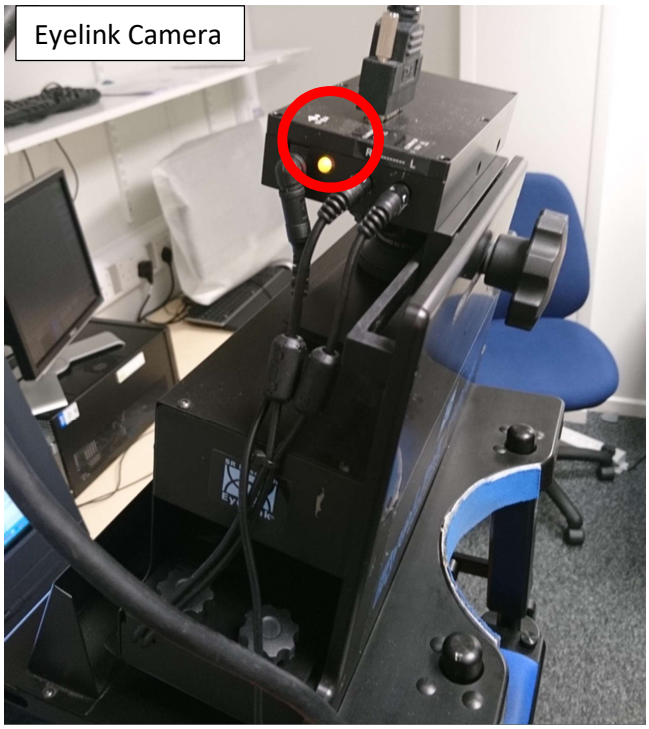
- When turned on, log on with cogneuro (password kilo1000).
- Set up the experiment as you usually would in MATLAB (correct directory etc, result = experimentName).
- Make sure it is facing the Eyelink camera
- Make sure it is straight

Eyelink PC – first screen



Setting up Eyelink PC

- When turned on, select 'Eyelink' to boot up in. This boots into the Eyelink operating system (OS). You should see the homepage for the Eyelink software (picture)
- If you ever find yourself on a black screen with white writing – this is DOS. You can type commands here. Type 'dir' to check there is enough free space (50,000,000 bytes). Then type 'elcl' to start the Eyelink software.
- You can get back to DOS by Ctrl+Alt+Q



Setting up Eyelink camera

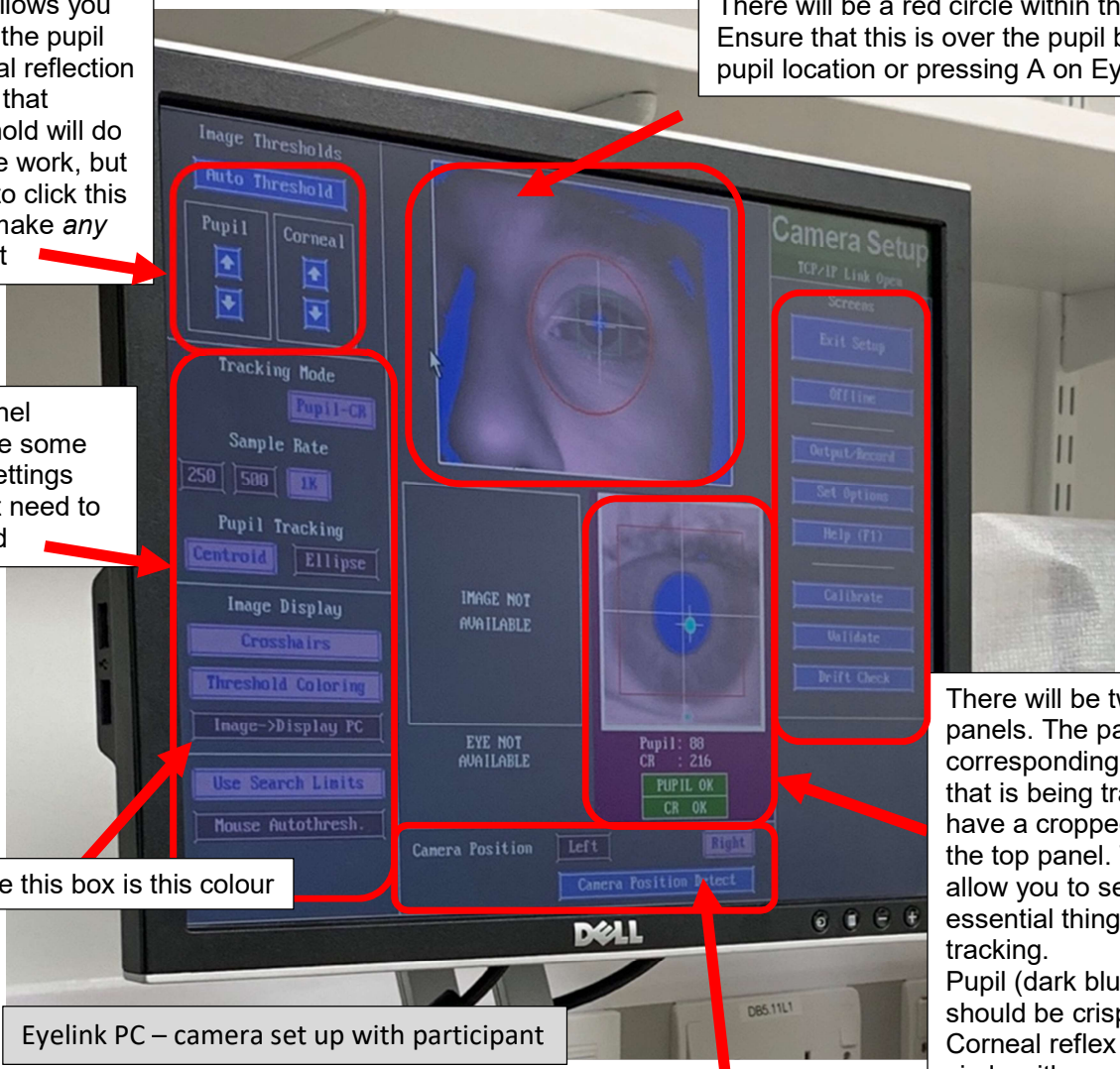
- Make sure the camera is turned on (yellow light glowing)
- Check that the Eyelink camera has the right resistance setting on the plug socket
- Check that you know which eye is currently selected (rotate the wheel anticlockwise to loosen the camera, and gently slide to the left/right as required).
- Make sure the distance to the stimulus PC is what you think it is

Setting up the participant

- Check they are not colourblind, note prescription if wearing glasses/contacts
- Advise them to keep their head still and just move their eyes in the experiment
- Go through the instructions with them

Note that if calibration is difficult, revisit these steps to try and 'trick' the Eyelink.
Now you are ready to start the experiment.

1) Press enter/run on the stimulus PC. You should see the Eyelink PC change display to a camera set up page (picture below). If not – something has gone wrong.
2) Getting the participant comfortable is very important. Their chin should be resting on a cushioned rest, and their foreheads against a blue cushioned strap. There are a number of options. Ensure they are sat as close to the monitor table as possible
    a. Move the seat up and down
    b. Move the stimulus PC table up and down (remote under the table)
    c. Adjust the chin rest height with side screws (rotate in opposite directions, i.e. right hand away from PC, left hand towards the PC). The participant should be looking straight ahead, unless you want the head at an angle for some specific reason.
    d. Adjust the forehead rest position with side pegs (carefully pull away from the camera/stand, then lower or raise the camera accordingly, note the pegs mean that there are defined settings). Forehead rest should be just above eyebrows
3) Once the participant is comfortable, explain that we need to turn the lights off to help the camera to calibrate. Turn the lights off, and turn the Eyelink PC monitor away from the participant.
4) Recognizing the camera set up page



This box allows you to change the pupil and corneal reflection size. Note that autothreshold will do most of the work, but you need to click this after you make *any* adjustment

The top panel should display the eye and some of the surrounding facial areas.
There will be a red circle within this panel. Ensure that this is over the pupil by clicking the pupil location or pressing A on Eyelink PC

The left panel should have some standard settings which don't need to be changed

There will be two lower panels. The panel corresponding to the eye that is being tracked will have a cropped view of the top panel. This will allow you to see two essential things for eye tracking.
Pupil (dark blue circle, should be crisp)
Corneal reflex (turquoise circle with crosshair)

Make sure this box is this colour

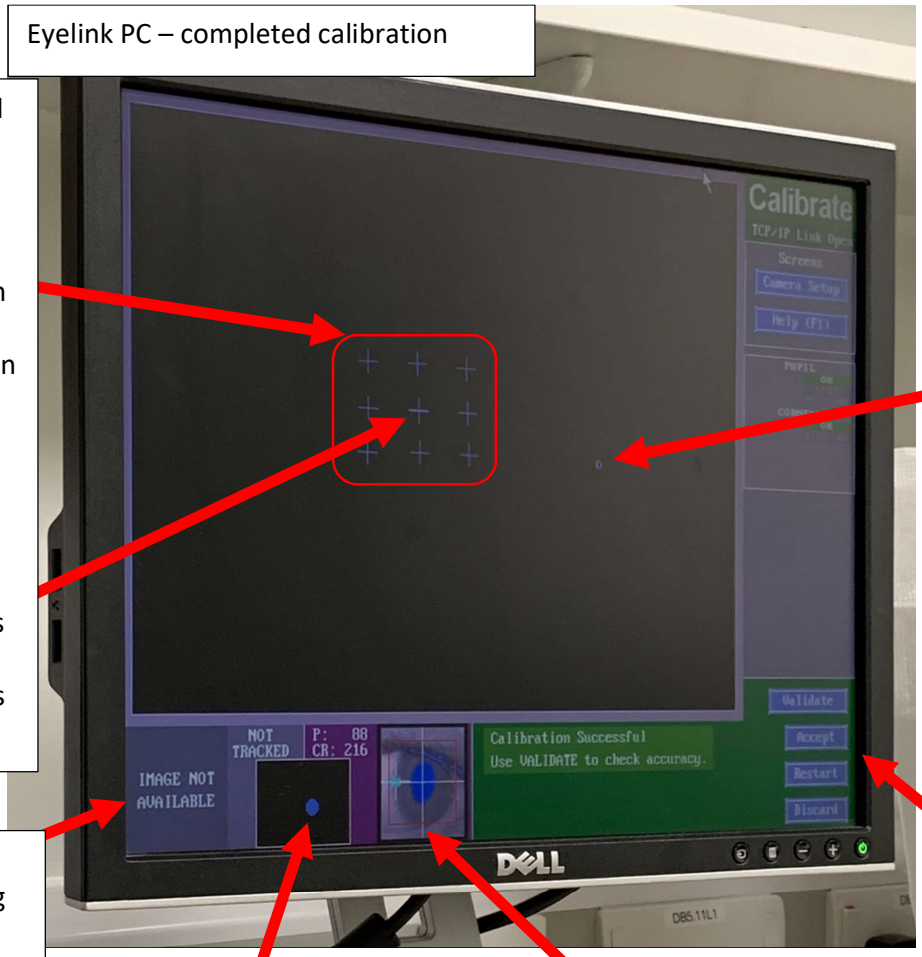
Eyelink PC – camera set up with participant

Note if you change the tracked eye during this period, you may well have to tell the camera that you have done so.

5) Get the camera set up as well as possible to see eye fully and get crisp pupil and corneal reflection. Initially, click 'autothreshold' to see the best possible option according to Eyelink.
    a. Adjust the focus lever on the top of the camera.
    b. Adjust the mirror on the Eyelink camera (screws same as chin rest).
        i. Note that the mirror and the focus will change one another, so be sure to compensate for any adjustments
        ii. The mirror can help with glasses
    c. 'Autothreshold' again
    d. Increase the size of the pupil/corneal if necessary with the top left box.
        i. Pupil should be fully coloured blue, but the eyelashes should not.
        ii. Corneal reflex should be a circle.

When you have a steady crosshair – you can begin to calibrate

6) Calibration is a vital stage. Click ‘Calibrate’ or press C.
    a. At this point, the stimulus PC will turn black with a white circle (with a small black dot) in the middle of it. This is the first circle to calibrate.
    b. 9 more will come up (corners and edges, then the middle again).
    c. You can ask the Eyelink PC to bring these circles up automatically (ensure autotrigger is clicked or press A, note you may have to accept fixation once or twice to set the trigger off), or accept the fixation manually (click or press space bar).
    d. For patient participants, it is likely that autotrigger will be unsuccessful. More on this later, but a particularly important stage is to align the two centre crosshairs. If happy with the calibration, click Accept. If not, click Restart.



Eyelink PC – completed calibration

Ideally this should match the shape of the screen as much as possible. Definitely ensure that none of them overlap or are missing. Slanting in one direction (more trapezium than square) isn’t too much of a problem. Ensure the two central crosses overlap as much as possible to avoid problems with fixation.

This keeps track of the eye position on the screen

Note that as we are only tracking the right eye in this example, the left image will not be available

This will mirror the movement of the subjects eye

This will show the movement of the subjects eye

Click ‘Accept’ if happy with calibration (which returns you to the setup page. ‘Restart’ if it looks bad.

7) Validation (if required) Press V or click ‘Validate’ followed by A (automatic) to start validation.
    a. This will show more dots around the screen, and a line showing the discrepancy of their eye position and where the eye tracker expects it. It will

redo the points that are ‘bad’. If the points overlay the dots closely this is good.

8) When happy with the calibration and validation, click Exit Setup. After a very short delay, the stimulus PC should now show your first experiment screen (Start of Experiment or something similar).

Running the experiment

1) During each trial, you can select ‘plot view’ or ‘pupil view’. Plot view shows a graph with time on x-axis, and y-axis showing the horizontal and vertical eye positions as separate lines. Pupil view shows the screen and a dot showing where the eye is looking.
2) The most important thing is to check is Plot View during practice trials/the first few trials of the experiment.
    a. Bear in mind physiological possibilities of eye movements, and also the quality of the signal. For example, if in a task where participants are asked to look from left to right, if the x position (turquoise) looks sinusoidal, not boxcar, then you may have a problem.
3) Do advise the participants to take a break, but be wary that long breaks often lead to a different head position, and hence the need to recalibrate. Short breaks are generally manageable (i.e. you don’t need to recalibrate), but use your judgement. Drift correction is performed online during most tasks.
    a. FOR SANJAY’S EXPERIMENT FRAMEWORK ONLY
        i. Recalibration can be called by pressing and holding the C key on the stimulus PC at the end of a trial.
        ii. Exiting the experiment by holding ‘escape’, and restarting using ‘result=experimentName(result)’ will pick up where you left off.
        iii. You can also perform a drift check at the start of each block (put the command “EyelinkDoDriftCorrection(el);” into your blockStart function), which will do a 1-point calibration check so you can see if the eye tracking is still accurate or needs to be recalibrated. This will not perform any calibrations here, but you can press ‘screen setup’ and recalibrate via that, and then ‘exit setup’ which will bring you back to this 1-point drift check, and passing that will continue the task.
4) At the end of the experiment, you should see something along the lines of “downloading edf”. This means that the edf file is being transferred to the current folder of the stimulus PC.
    a. Note that edf’s are timestamped “month,day,24hourtime” e.g. “03291230” means created at 12:30 on 29th March. Check that your timestamp makes sense with your experiment timings.
5) Make sure you save your result variable
    a. FOR SANJAY’S EXPERIMENT FRAMEWORK ONLY
        i. RunExperiment will create timestamped result file in the current directory automatically. Check that this timestamp corresponds with the edf.
        ii. Check in the result file that result.edfFiles is a reasonable match for time.
6) Shut down computers (Eyelink PC – just press power button, Stimulus PC do proper shutdown)

Troubleshooting

try the other eye with all of these techniques as well

Easy fixes and things to try straight away

1. Ask participants to open their eyes widely and keep them like that
2. Offer a drink or a walk in the break

Warning signs

(see point 1 in running the experiment) – always look at the Eyelink PC

1. Crosshair vanishes (e.g. for more than half a second) during trial,
2. Trial takes longer than usual to complete, or there is a pause before the foreperiod
3. Orange square appears in middle of screen: Ask participant to keep eyes on centre of screen. After 4 seconds, if eye is detected correctly, experiment will continue.
4. Eye position appears to jump around erratically or oscillate on the Eyelink PC.
5. A large blue region is visible above the pupil on the camera image
6. A large yellow spot, or yellow grids, are visible outside the eye on the camera image
7. Their gaze is drifting when it looks like it shouldn't be.
8. The gaze is jumping around erratically.
9. The gaze is consistently getting lost when they look at certain areas of the screen.

Eye lashes

Sometimes long eyelashes will droop down in front of the pupil. The machine will lose track of their eyes when they look in certain locations

1. Try changing the angle of the mirror (making it flatter often helps)
2. Ask them to brush their eyelashes up regularly i.e. at the start of each block
3. You can try adjusting the pupil threshold so it does not pick up the eye lashes

Tiredness

You can usually tell if tiredness is affecting things if:

1. Their eyes tend to drift when they are supposed to be fixating one place
2. They find it hard to stay focused on the calibration cue and look elsewhere
3. Sinusoidal or very noise traces appear in Plot View
4. Droopy eyelids
5. Try to fix tiredness by
    1. Turning the temperature down
    2. Drink/break/walk
    3. Remind them of task/incentives/inform them how long left until break

Glasses

There will be a reflection with glasses, which interferes with the corneal reflection

1. Try with no glasses (if possible), unless your task requires visual discrimination
2. Do they have *contact lenses*? Tracking is much better with contacts
3. If required, *clean* the glasses. Faint (invisible) smudges will cause interference
4. Try adjusting the glasses *position*, up or down the nose
5. If the reflection remains bad, try adjusting the *height* of the camera and the mirror simultaneously, so that the camera is "looking around" the reflection
6. Change the mirror angle so that the two reflections appear in different locations

Other things to try and fix lack of fixation (extremely common problem)

1. Is their head forwards enough? Instruct to keep head fully against forehead rest
2. Ask them to bring their chin forwards (if comfortable)
3. Remove mascara / other eye make-up

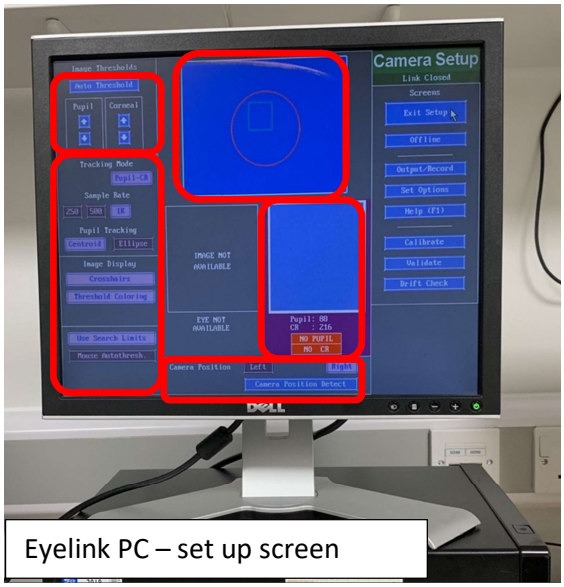
4. Ensure no hair in front of face
5. Ask them to brush their eyelashes upwards
6. Instruct to keep eyes wide open. Older participants may have a “ptosis” - naturally droopy eyelids. Eyelash problem is much worse with droopy eyelids. Tilting the head backwards (i.e. move chin forwards) can help with this, or adjusting the mirror/camera to be from lower down.

Impossible subjects

1. Nystagmus
2. Albinos / very pale iris
3. Very long eyelashes
4. Sleepy subjects: if eyelid comes down over pupil you will lose the trace.
5. Any other participants which were consistently losing the trace or poor calibration

Converting the edf

1) Note – if you are not familiar with UNIX this section may seem alien. Follow the instructions verbatim a few times and it will start to make sense. All UNIX commands will appear to the right of an arrow. Anything to the left of the arrow is the path of the folder you are currently in. You want to convert the unreadable edf into a readable asc (simple text) file so that you can extract time course pupil size and position information
2) The stimulus PC has the necessary software to do this, but the minimum requirements are any Windows PC and the ‘edf2asc.exe’ file. Exe means executable file.
3) Open command prompt. (winkey + R, type ‘cmd’)
4) Set your current working directory to the location of your edf files.
    a. E.g. “cd myexperiment/resultfiles”
        i. “cd” means change directory to
        ii. Note that the path to the left of the file will now change
        iii. Also note that if your files are on a memory stick/hard drive, first type “G:” or “C:” to change disk, then “cd” to where your files are
5) Locate the full path (list of all the folders/subfolders) to the exe file and copy this to clipboard (right click copy or Ctrl+C)
    a. E.g. “myexperiment/tools/edf2asc.exe”
    b. Note that this exe is often buried in a conversion package called edf-converter-master. In this case the path will be something like this
        i. E.g. “edf-converter-master/edf2mat/private/edf2asc.exe”
6) What you now want to do is convert all the edf’s in your folder to asc. The command to run is as follows
    a. E.g. “edf-converter-master/edf2mat/private/edf2asc.exe *.edf”
        i. This line of UNIX means that you want to run the specified exe file in the folder that you’re currently in, and you want to do it on any file that ends with .edf (* means wildcard, i.e. the file name can be anything)
    b. At this point, it should start processing.
    c. If you have a corrupted edf for any reason, try running the below line
        i. “edf-converter-master/edf2mat/private/edf2asc.exe *.edf -failsafe”
        ii. – in UNIX means you’re specifying an option (in this case failsafe)



Eyelink PC – set up screen

No space to save data

Occasionally the eyelink PC says that there is not enough space to save data files (the .edf files are saved on this PC as well as transferred to the stimulus PC).
You need to move the .edf files to free up space.
You are supposed to be able to boot into Windows, and then move the data from the DOS partition to the Windows partition, but at time of writing it could not boot into Windows 7.

Instead, we are transferring all the data onto a USB stick, and copying that to the stimulus PC:

1. Get a FAT32 formatted USB stick with > 5 GB space
2. Plug it into the eyelink PC while it is off (it will not be recognised if it is not plugged in when computer starts up)
3. Start eyelink PC
4. Start eyelink.
    a. If it gives the space warning, press a key to stop startup, and it will exit into DOS
    b. If it opens up eyelink, press ALT + CTRL + Q to exit into DOS
5. Type “D:” to change to the D drive, which should be the USB stick (if this doesn’t work, try some other letters, or try “fdisk” to show drives)
6. Type “dir” to check you are in the right place
7. Type “mkdir edf” to create a folder to copy the data into
8. Type “move C:\elcl\data*.edf D:\edf” to move the edf files into this directory
    a. When I did this, after copying 6 files it would say “[Unable to open source]”. Then I needed to keep running the same command and it would work, but stop after each 7th file. If this happens, you can use a for loop to keep running the same command:
    b. “for %%A in (1 2 3 4 5) DO move C:\elcl\data*.edf D:\edf”
    c. This will run the same command 5 times. You can add more numbers if you want
9. After it has copied all the files, you should check there are none left:

a. D:
b. cd D:/edf
c. dir /s
d. C:
e. dir C:/elcl/data/ /s *.edf”

Other things clogging up space

There may be other types of files taking up space.

1. Check the file system integrity. If prompted to recover lost chains select YES. “chkdsk /f”
2. Remove any "found" files generated by chkdsk:
    a. cd c:\
    b. del /s *.CHK
    c. Remove logs and stored calibration models
    d. cd c:\elcl\exe
    e. del *.log
    f. del *.cal