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USING THE HEAD-MOUNTED EYELINK 2

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Definitions/Abbreviations	
RED	Research Enterprise and Development
R&D	Research and Development
IMP	Investigational Medicinal Product
SAE	Serious Adverse Event
UoB	University of Bristol
SOP	Standard Operating Procedure

1. PURPOSE:

To provide guidance on using the head-mounted Eyelink2 located in room 3D25 in the Experimental Psychology building.

Note that the owner of this lab is Dr Ute Leonards and you should defer to her for instruction on using this lab over this SOP.

2. PERSONNEL REQUIRED AND LEVEL OF EXPERTISE:

- Investigator or research team.

3. MATERIALS AND EQUIPMENT REQUIRED

- Note that these are the instructions on running the head-mounted Eyelink2 located in room 3D25 in the Experimental Psychology building. Other machines vary and the operating procedure will be different.
- This SOP assumes that you have a script in MATLAB with the necessary code to run an eye tracking experiment.
- Run using MATLAB Version 2009a.

4. PROCEDURE:

4.1. Before eye tracking

- Ask the owner of the lab and eye-tracker (Dr Ute Leonards) if the equipment and lab space can be used for the duration of your experiment
- Where appropriate, use the lab's calendar to book the lab space prior to use
- Obtain written consent from participants
- Explain the task to participants
- Measure the participant's dominant eye
 - Ask the participant to extend their arms in front of them and make a small hole with their hands, thumbs touching and to look through the hole.
 - Their dominant eye is the eye you can see through the hole. If you cannot see a single eye, ask them to bring their hands towards their face.

4.2. Turn on computers and prepare for eye tracking.

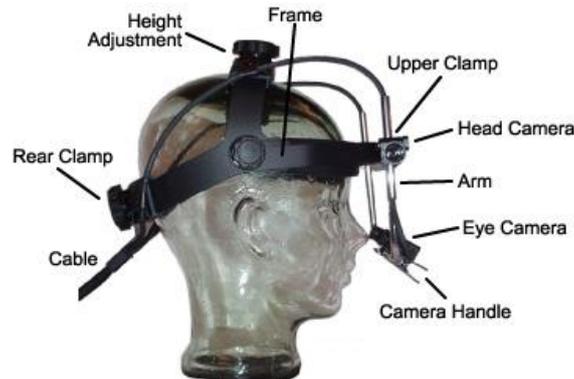
- Turn on the stimulus computer (desktop computer) and eye tracker computer (laptop). The logon information for the desktop is as follows: Username: 'administrator', please contact Olivia Maynard for password. To access the laptop computer (eye tracker computer), type 'eyelink2' into the command line.
- The Eyelink system on the laptop should run for 5 minutes after switching on power to the desktop (stimulus) computer before starting eye tracking.

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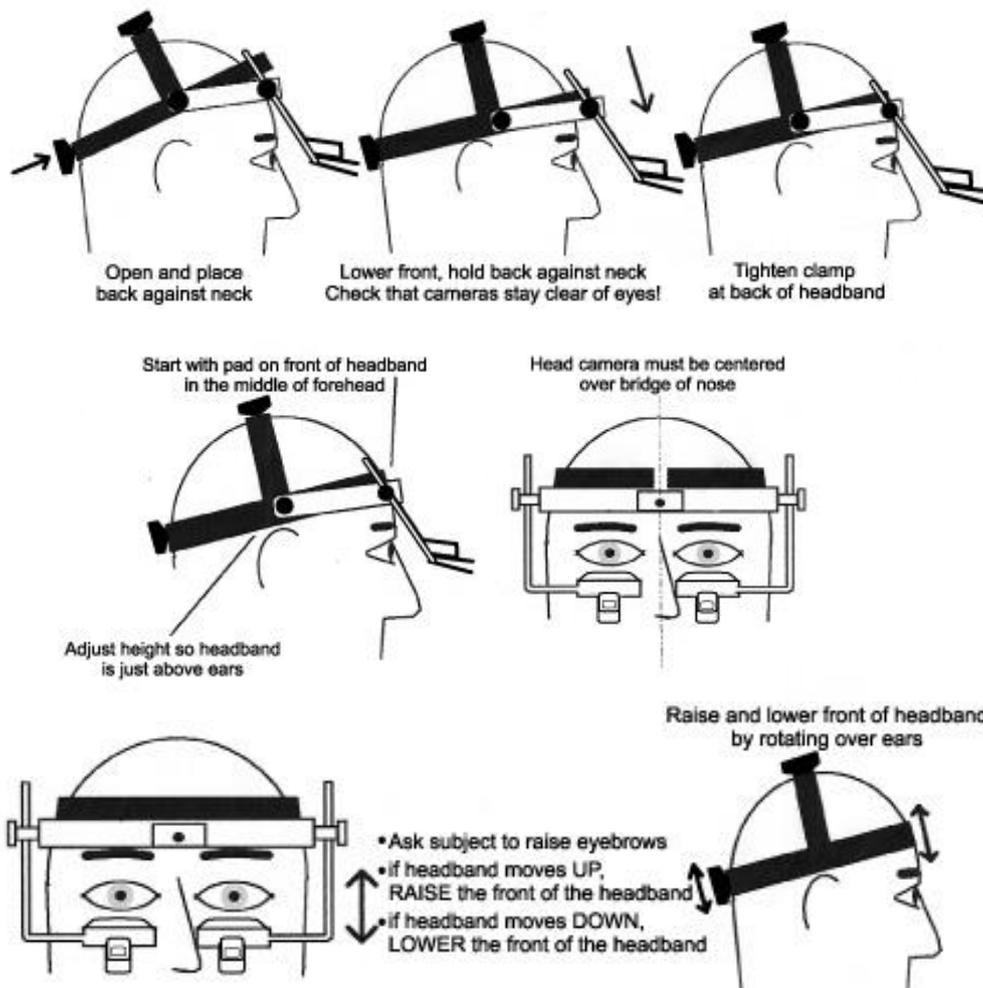
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- Load MATLAB on the desktop computer (stimulus computer) and load directory with your script, run script including necessary parameters for eye tracking.

4.3. Setting up the eye tracker



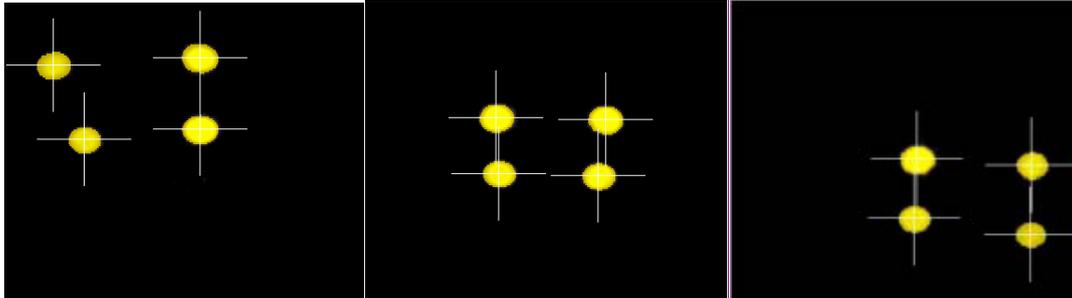
- Ensure the participant is sitting comfortably at the correct distance from the screen. The swivel chair can be moved, but the chin rest cannot. Place a piece of tissue paper on the chin rest before the participant rests on it.
- Carefully lift eye tracker head-piece from dummy head and place on participant's head. Tighten the two screws until they are relatively tight on the participant's head and the head-piece cannot be easily moved. Ensure the participant is comfortable.



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- Ensure the cable for the eye tracker is not twisted.
- Ensure that no hair is trapped between the forehead and the front pad of the headband as this will cause the headband to slip.
- Looking at the laptop screen, ensure that the 4 dots for the 'Head Camera' view are aligned in a square, rearrange head-piece and participant's head if not.



Move participant's
head to the left and up

Good

Move participant's head
to the right and down

- Turn the light off in the room and allow the participant time to adapt to the light.
- On the laptop, select setup cameras, which will take you to the central screen for setup functions.
- Select the eye you wish to track (usually the participant's dominant eye) by using the arrow buttons to switch between the left and right eye cameras.
- Move the cameras attached to the head-piece so that the image on screen includes the whole eye. The pupil should be in the centre of the image. Remember that the camera can be moved in a number of different planes to obtain the optimal position. Ensure the camera does not obstruct the participant's view of the screen. The camera's focus can be altered by turning the small wheel attached to the left or right camera.
- Press the 'Auto threshold' button on the laptop screen. The participant's pupil should be coloured in blue on the image on the laptop screen and as little as possible of the remainder of the eye or eyelid/lash should be blue. If participants are wearing eye makeup this can make the eyelashes show up as blue, which would degrade the signal. Ask participants to remove eye makeup in this case. The threshold (amount of blue) can be altered manually by pressing the up and down arrows on screen in the 'Pupil' box. Aim for the entire pupil to be blue, but nothing else.
- At this point, there are two modes of tracking that can be used: Pupil only and Pupil-CR (corneal reflection). If choosing Pupil-CR mode it is important to have the head camera bar as low as possible to maximise the ability of the CR illuminators. If present, this reflection will appear as a yellow dot towards the top of the pupil surrounded by a white crosshair. The threshold for the CR can be automatically set and altered manually by pressing the up and down arrows on screen.
- Ask the participant to look along the edges of the computer screen. Ensure that the horizontal and vertical axes on the screen meet in the centre of the pupil and that these are visible at all times. If not, the camera position or focus may need adjusting. Ensure that whilst the participant is looking around the screen, the message underneath the small image of the eye you are tracking is green and says 'PUPIL OK' at all times. Rearrange camera if not. If in Pupil-CR mode, ensure the yellow dot and cross hairs are visible at all times. Note that corneal reflection will not be stable with all participants, in which case Pupil only mode should be used.

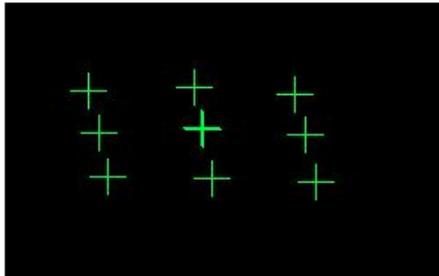
4.4. Running the calibration

- When happy with the position of the camera, run the calibration (ensure you have informed the participant of what this will involve). This can be run on both eyes which allows the program to automatically select which eye to track based on which had the best calibration. Alternatively, one eye can be chosen to track by locking the other out. These options can be chosen in the Eye to Track section of the camera setup screen.
- To begin the calibration, press either the 'Calibration' button on the laptop screen, or press 'c' on the keyboard.

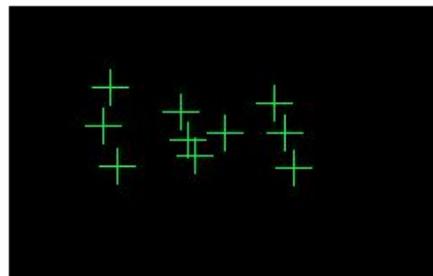
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- A 9 point calibration is usually run, but this can be changed by pressing the 'Set Options' button and changing to the desired size calibration.
- When participants are fixating on the cross on their computer screen, the box in the bottom right corner of the laptop screen will turn green and will say 'Stable'. Press the spacebar (quietly) when you are sure they are looking at the cross, cross-validate the box in the bottom right hand corner and the position of their pupil as compared with the position of the cross as shown on the laptop screen. Repeat for all 9 fixation points.
- If this is a good calibration (the 9 points will be in a relatively evenly spaced 3x3 rectangle, run the validation by pressing either the 'Validation' button or 'v' on the keyboard. If it is a poor calibration, press the 'Abort' button and re-run the calibration. For the validation, again, press the spacebar when participants are fixating the crosses.



Good Calibration



Poor Calibration

- Once this is complete, the laptop screen will display the error scores for each of these points. The mean error score, as reported in the light green box at the bottom of the screen (this box will be red if it is a particularly bad calibration) should be less than 0.4. This is measured in degrees of visual angle, and, if the participant is sat 57cm from the computer screen, means that you can assess where they are looking with an accuracy of 4mm.
- If the error score is 0.4 or below, press 'Accept'. This will return you to the 'Camera Setup' screen. When ready to start the task, press 'Esc' on the laptop keyboard.
- If the error score is above 0.4, press 'Restart'. This will take you to the Validation screen; if only the validation was poor, then only re-run this. If the calibration was also poor, press 'Abort', re-setup the head-piece as necessary and press 'Calibrate' again.
- The calibration can sometimes take a long time, be patient and allow the participant a break if it is taking a very long time. If it takes over 10 minutes, it is unlikely that it will work and the participant will not be able to participate. You should have a procedure to deal with this scenario regarding compensation. It is a good idea to write in the information sheet that it is difficult to track the eyes of some participants and if it does not work for a participant, then they will be reimbursed with x amount (or whatever the procedure is).
- Tips for a good calibration:
 - Remind participants that they should fixate directly in the centre of the fixation cross and not anticipate the next cross appearing.
 - During the calibration, pressing the backspace button will erase the previous point collected and re-run it if it is bad. This is especially useful for participants for whom it is difficult to calibrate.
 - Participant must keep as still as possible and not move after the calibration/validation is complete.
 - Use the notch at the middle of the headband to ensure it is central above the participants' nose.

4.5. Drift correct during the task

- If your code has drift correction between trials (a good idea if it is a long experiment, or if you want to make sure participants are looking at the centre of the screen at the beginning of each trial) you will need to watch their eye movements on the laptop screen when the drift correct cross appears between trials and press the spacebar when they are fixating this point.
- It is important to ensure that the participant is definitely looking at the cross when you press the spacebar. Once you've pressed the spacebar, for a second afterwards, an image of the location of

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the participant's fixation alongside the location of the fixation cross will appear on the laptop screen. If the centre of the participant's fixation does not overlap with any of the fixation cross, then you should consider rerunning the calibration. This should be avoided if possible and can be, by ensuring a good calibration to start with. To rerun the calibration during the task, press the 'Setup camera' button on the laptop screen and run the calibration and validation routines as previously. The experiment will then recommence where it left off.

4.6. Finishing eye tracking

- Remove the head-piece from the participant's head and replace carefully on the dummy head.
- Shutdown the laptop by pressing the 'Exit Eyelink' button and then press the power button on the keyboard.
- Remove the tissue paper from the chin rest and clean the band of the head-piece. This can get dirty quickly if participants are wearing makeup – wet-wipes are good for this.
- There is no virus software on the computer. Ensure that any USB sticks put into the computer are 'clean' and have been checked using a computer with virus checking software.
- The data needs to be backed up between every participant.
- The amount of space on the Eyelink computer (laptop) needs to be regularly checked.

4.7. General eye tracking tips

- Participants should remove dark eye makeup. It is good practice to keep eye makeup remover pads (and ideally a mirror) in the lab.
- Eye tracking with participants with glasses is difficult and sometimes impossible. Wearing glasses can be an exclusion criterion for an eye tracking study. Participants may wear contact lenses.
- Eye tracking should be conducted in a dark lab. Participants can also get drowsy doing eye tracking, 3D25 has air conditioning which should be on (around 20°C or lower during the experiment).
- During testing, put the sign saying 'Testing in Progress' on the outside of the door.
- The participant should be reminded not to move (or talk) throughout the experiment, including during the calibration.
- As the experimenter, although you will be operating the eye tracking computer during the task (if doing drift correct), do not distract the participant. Do not make loud noises, do not tap the keyboard too loudly, do not drum your fingers, do not do anything which might elicit the participant to speak unnecessarily etc as this can move their eye position.
- More information on the Eyelink2 can be found in their online manual <http://www.mshs.univ-poitiers.fr/ressources/eyetracking/EyeLink%20II%20Head%20Mounted%20User%20Manual%202.12.pdf>

4.8. Eye tracking analysis

- Eyetracking data will be saved as an .edf file in MATLAB. You will need to convert these files to .asc files before analysing the data. You will need to download an edf2asc converter file to do this.
- Dr Casimir Ludwig has created a wiki page which describes how to extract this data <http://casiwiki.pbworks.com/w/page/15355613/Analysing%20data>

5. TROUBLE SHOOTING:

Problem	Solution
Any problems	TARG Laboratory phone: 07957334265 Olivia Maynard (0117) 92 89943 internal 89943 Olivia.Maynard@bristol.ac.uk