SUPPLEMENTARY MATERIAL 3 *IMAGE CAPTURE AND ANALYSIS METHOD*

Background

In order to collect detailed information on the nature of eye movement training provided an image capture and analysis method was used. The aim of this method was to determine the area of visual field (in degrees) that was stimulated by each intervention, and the size (in degrees) of the targets used to stimulate these movements. Both of these could be calculated if the size and distance from the eye are known: a method was required to obtain accurate measures of the size of intervention training area and stimuli. It was important the method could allow measurement of moving images, as interventions used exercises and games with moving targets. Following discussion with researchers and technicians from the physiotherapy, vision sciences and computing departments within the university, an image capture process, using a video camera, followed by further computer-based analysis was used.

Equipment

- 10 identified interventions (Table 4-1) (and table if required)
- HD camera - Samsung HMX f80SN HD camera
- Camera tripod
- Tape measure
- *size reference* –small, flat plastic card
- Vernier caliper
- Computer with Photoshop (from Adobe Master Collection CS5)

Method

Data Collection

1. the dimensions of the *size reference* were measured using a Vernier calipre. Five measures were taken, the lowest and highest removed, and the mean of the remaining three taken as a true value of its dimensions and used as a *reference value* for data analysis.
2. the camera was tripod mounted, and tripod spirit level used to ensure it was level. The intervention being explored was set up: computer and paper-based interventions were placed on a table, 150 cm from the camera. Tripod height was adjusted to give horizontal centration of camera and intervention, zoom adjusted to ensure the entire training area was visible and focus adjusted manually to maximise image clarity.
3. An image of the easiest exercise was obtained: for static exercises a photograph was taken, for moving exercises a 30 sec recording was made. Without changing the setup, a second still image was captured, with the *size reference* included.

   Steps 2-3 were repeated for all 10 interventions.

Data Analysis

1. images were transferred from camera to computer via USB stick and opened in Photoshop. The measurement features of Photoshop were enabled: this allowed the number of pixels between two marked points to be recorded.
2. the number of pixels between the top and bottom and left and right edges of the *size reference* were obtained by using the mouse to mark these points. A mm-to-pixel ratio for was determined in excel by dividing the *reference value* (mm) by the pixel count for horizontal and vertical *size reference* dimensions.
3. the pixel counts for the maximum horizontal and vertical dimensions of the training area and training stimuli were obtained by marking them in the same way.

Steps 2-3 were repeated for all 10 interventions

Calculations

1. the distance of the user from the intervention was either taken from associated literature or instructions if available, or else Optometry standard working distances for computer and book use were used.
2. In excel, the visual field size A was determined based on the trigonometry equation that tan A = measurement size (mm) / working distance (mm). This calculated for all intervention measurements.

Conclusion

This method allowed for the extent of the visual field covered by each intervention and the size of training target to be determined in an accurate, systematic way. The reliability of the method was confirmed (below). This provided clinically relevant results and allowed comparison between interventions.

Process for determining the accuracy and precision of image capture techniques.

Aim

In order to reflect the range of measurements required for the identified interventions, the exploration examined the accuracy and precision for the following distance measurements variables:

- Size: 1, 10 &50 mm
- Orientation: horizontally, vertically and diagonally

- Location: centrally or peripherally in the analysed image

It also investigated the effect of the camera distance from the object recorded.

Accuracy was determined by comparing the true size of standardised sources with the size as determined by the process of image recording and analysis. Precision was determined by comparing the results obtained from repetition of specific measurements five times.

Method

Equipment setup: The Samsung HMX f80SN HD camera was tripod-mounted, with full room lighting. Manual focus and zoom controls were used to maximise image size. A standard of known size was positioned with horizontal, vertical and diagonal orientation, and at distance of 50 and 150 cm from the video-camera. This equipment setup, capture and analysis were repeated 5 times.

Image capture: for each orientation and camera distance the images were recorded as noted in the above

Image analysis: For each ruler orientation two points were selected at the periphery and centre of the image for analysis.

Calculations: Pixel counts and frame counts were used to calculate distances and times as noted in the text. SPSS software (v19) was used to test normality and to calculate mean, range, standard deviation and variation (standard deviation / mean x100) to explore precision. To explore accuracy the bias value (measurement –true value) and % bias (measurement – true value x100) were calculated.

Results

Precision: For a 1mm standardised value the measured value was 0.989 ± 0.097, for 10mm it was 10.146 ± 0.143 and for 50 mm it was 50.584 ±0.567. The largest difference in variation within these, as denoted by standard deviation, was associated with a change in the camera distance. Using measurements taken at 150 cm only reduced the standard deviation to 0.086, 0.100 and 0.233 respectively. 95% of measurements therefore lie within 0.95± 0.17, 10.07 ±0.2 and 50.20 ± 0.47 for 1mm, 10mm and 50 mm true values respectively. As the mean value here are not equal to the true value, it suggests there were also some non-random sources of error, which are assessed below.

Accuracy: The percentage bias for the averaged measures of 1mm, 10mm and 50mm were 1.09, 1.46 and 1.17%. The camera distance was again associated with most difference in % bias values, with 150cm appearing to give a lower level of bias. A one sample student t test was used to determine the statistical significance: for the averages of the 1, 10 & 50 mm measures this showed that only the 1mm values were statistically biased (p=0.55). When the values were analysed separately based on the camera distance, the bias for the 50 cm camera distance remained significant, but fell to p=0.001 for 150 cm values.

Conclusion

The precision of this technique is seen to be highest when using a camera set at 150cm, as opposed to 50cm. The level of bias is reduced when the 150cm camera distance was used, no longer reaching levels of statistical significance for all reference values. This measurement technique was appropriately accurate and precise for the purposes of this study when used in this way. Only measurements made with the camera set at 150 cm were used in the study's intervention description process.