Novel approaches to automated, real-time eye-movement classification in infants and adults

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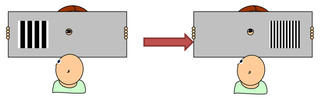
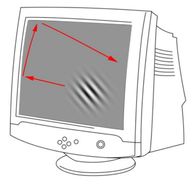
1 Introduction

We are developing new vision tests for 0—18 month infants using remote eye tracking. The present work regards a new test of visual acuity, as measured by the finest grating that can be distinguished from a uniform luminance background.



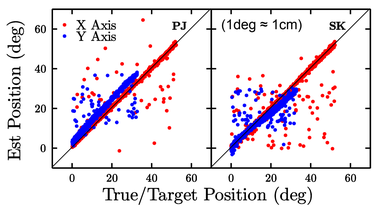
Teller cards are the current gold standard. 'Did the infant look at the patterned side?' *Cons:* Slow. Labour intensive. Low resolution.

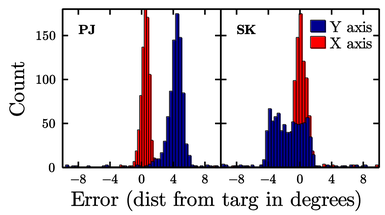
We are attempting to replace this with an automated adaptive eyetracking protocol. 'Did the infant look at the moving Gabor patch?' This should allow for faster and more precise measurements



2 Eyetracking data extraction

- Sampling at 60 Hz using table-mounted eyetracker (Tobii X120)
- Low-pass moving-average filter (k=5)
- Linearly interpolating over missing values (n ≤ 2)
- UV filter to minimise corneal reflection



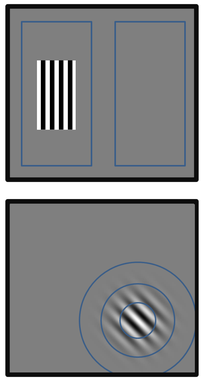


In adults, results accurate and precise in the horizontal plane, but more variable in the vertical plane (SK, fig2), and prone to bias

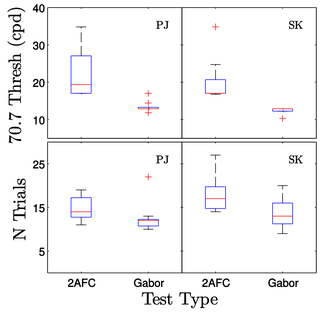
Q. *How to improve vertical accuracy and precision?*

3 Classifying fixations: 2 approaches

2AFC The traditional approach is based on preferential looking. A grating is placed at one of two locations. Observer is judged to have looked at the grating if that screen locations received the longest dwell-time



Loglikelihood a Gabor patch is placed a random location, and the most likely object-of-fixation is computed probabilistically. The 2 alternative 'objects' were a screen-wide, uniform distribution (random search), and a bivariate Gaussian centred on the Gabor



In adults, estimated acuity was lower in the Gabor version, but estimated thresholds were more consistent and required fewer trials. The difference in threshold magnitude was likely because in the 2AFC version the target could always be fixated centrally.

4 Acuity in 3 – 9 month infants

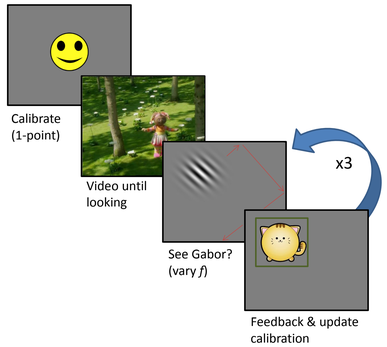
Infants seated on their parent's lap, 1m from monitor in a blacked-out area with dim lighting. Total test time ≤ 5 mins

At the start of the test a single-point calibration was performed (then updated after every trial)

Trials were intercut with videos to maintain attention (~8sec)

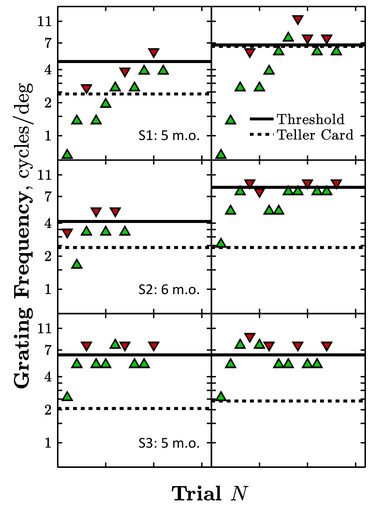
3 Gabor trials between videos. Moving stimulus & music (~3sec)

Feedback & sounds after each trial (not conditional on look)



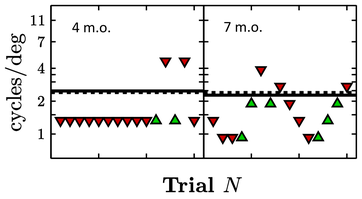
4.1 Results

1down-1up staircase used to estimate threshold (stop after 4 reversals). Frequency of the Gabor patch increased if fixated upon (green), decreased if the infant looked elsewhere on the screen (red). Preliminary data for 3 subjects shown right.



Estimated acuity (black lines) was consistently higher than the Teller card equivalents (dashed lines).

Thresholds for both measures were relatively consistent across repeated blocks.



However, some infants (~10%) gave patchy data (poor contact with eyetracker, due to excessive movement or aspects of their eyes). Moreover, many babies (~30%) were inattentive, either throughout (left), or after approaching threshold (right).

Q. *How to attract and maintain infants' attention during testing?*

Q. *How to generally improve the eyetracking signal in infants?*

5 Conclusions and future work

We have demonstrated that a simple eyetracking protocol can be used to assess visual acuity in *some* infants. However, some infants were uninterested in the task, and we are actively looking into ways to make it more engaging.

The next step is to validate this test, looking at test-retest reliability. We are also developing a gaze-conditional tests of the visual field.

For much of the Matlab code developed for this work:
https://code.google.com/p/infantvision

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