An automated test of infant visual acuity using remote eyetracking

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1 Summary
We have developed a novel test of visual acuity, appropriate for use with preverbal infants. The test is completely automated, and takes around two minutes to complete. Accuracy and reliability compare favorably with the current gold standard: Acuity Cards.

2 Background & Methods

Acuity cards are currently the best clinical measure of infant acuity. “Did the infant look at the stripes?”

Our test replaces the cards with a digital screen, and the observer with an eyetracker (Tobii X120). This affords greater accuracy and precision (e.g., stimuli were always presented 8° from fixation at trial-onset).

The infant sat on their parent’s lap and viewed Gabor gratings that varied in spatial frequency across trials. On each trial, the grating was presented at a random location (8° from fixation), against an isoluminant grey background.

The spatial frequency of the Gabor grating was adjusted automatically by the computer, until the infant’s detection threshold was found (threshold = max-correct, using a up-2 down-1 weighted staircase).

3 Results: Accuracy

Visual acuity increased with age ($p = 0.98$ cpd/month; $p < 0.01$), and the results were correlated with Keeler Acuity Card estimates ($r_{26} = 0.51$, $p < 0.01$).

There was also good agreement with previous normative data. 46 (78%) of the individual estimates, and 27 (90%) of the within-subject means lay within the 90% tolerance limits reported by Salomao & Ventura (1995), and there was no significant difference in how acuity improved with age ($\beta_{norm} = 1.00$ cpd/month; $p = 0.71$, n.s.).

4 Results: Test-Retest Reliability

Absolute acuity varied by 0.83 octaves (0.25 logMar) on average, with 86% tests varying by ~1 octave or less.

In general there was less difference between retests using Acuity Cards ($\beta_{cards} = 0.40$; $\beta_{eyetracker} = 0.83$ octaves), but the difference in variability was not significant ($p = 0.46$, n.s.).

5 Results: Errors

Catch trials were used to assess error rates. Guessing rates (hitting an invisible target) were 7%. Lapse rates (missing a low frequency grating) were 26%. The risk of false-positives is therefore low, but additional work to keep infants interested/motivated may be beneficial.

Hit rates were relatively consistent, irrespective of where in the visual field the target was presented.

6 Future Work

We have demonstrated that an automated eyetracking protocol can be used to assess infant visual acuity. We are now expanding the scope of the test to measure contrast sensitivity and visual field.

The same approach can also be adapted to specific patient groups, (e.g. chromatic stimuli to measure cone function).

References:

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