An automated test of infant visual acuity using remote eyetracking

#65

Pete R Jones[1], Sarah Kalwarowsky[1], John Wattam-Bell[2], Janette Atkinson[3,4], Oliver J. Braddick[4], Marko Nardini[1,5]

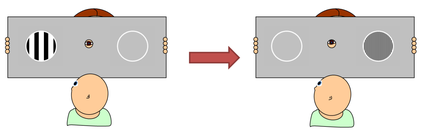
p.r.jones@ucl.ac.uk ; Commercial Relationships: None

[1] UCL Institute of Ophthalmology, UK
[2] UCL Division of Psychology and Language Sciences, UK
[3] UCL Department of Developmental Science, UK
[4] Department of Experimental Psychology, University of Oxford, UK
[5] Department of Psychology, Durham University, UK

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.

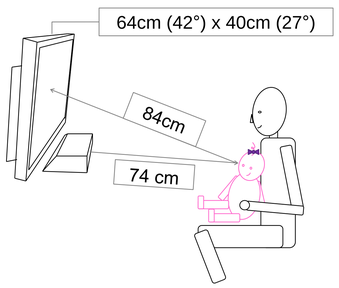
2 Background & Methods



Acuity cards are currently the best clinical measure of infant acuity.
"Did the infant look at the stripes?"
Cons: Labour intensive. Subjective. Inflexible.

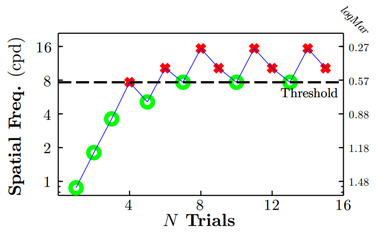
Our test replaces the cards with a digital screen, and the observer with an eyetracker (Tobii X120). This affords greater accuracy and precision (e.g., stimuli were always presented 8° from fixation at trial-onset).





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.

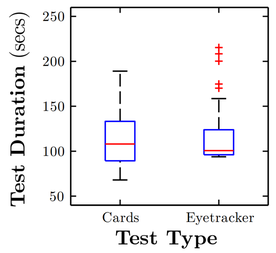
The spatial frequency of the Gabor grating was adjusted automatically by the computer, until the infant's detection threshold was found (threshold = max-correct, using a up-2 down-1 weighted staircase).



2 Results: *Testability*

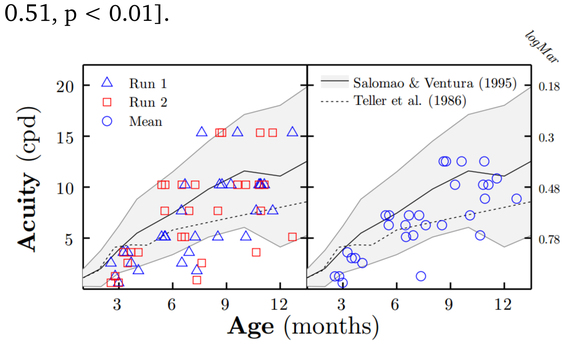
Of 30 infants tested, 100% completed the test once, and 97% completed it twice.

Median test duration was 101 seconds (no significant difference from Acuity Cards; $p = 0.12$, *n.s.*).



3 Results: *Accuracy*

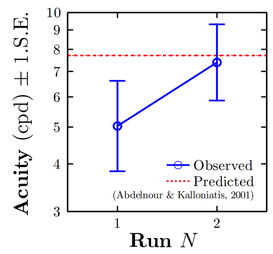
Visual acuity increased with age [$\beta = 0.98$ cpd/month; $p < 0.01$], and the results were correlated with Keeler Acuity Card estimates [$r_{28} = 0.51$, p < 0.01].



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 [βnorm = 1.00 cpd/month; p = 0.71, n.s.].

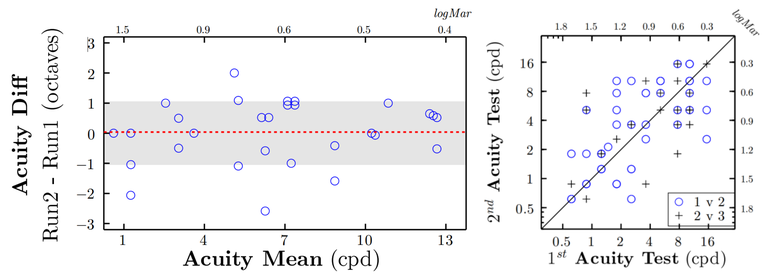
Adult Data

As a further sanity-check, eight adults were also tested using a low (10%) contrast version of the same test. The acuity estimates over two runs were consistent with previously reported values [$p_{run1} = 0.18$, $p_{run2} = 0.93$ *n.s.*].



4 Results: *Test-Retest Reliability*

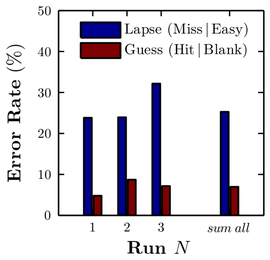
Absolute acuity varied by 0.83 octaves (0.25 *logMar*) on average, with 86% retests varying by ~1 octave or less.

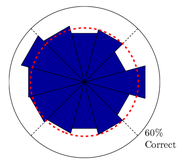


In general there was less difference between retests using Acuity Cards [$\mu_{Cards} = 0.40$; $\mu_{Eyetracker} = 0.83$ octaves], but the difference in variability was not significant [$p = 0.46$, *n.s.*].

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).

[1] Salomao & Ventura (1995) Inv. Opth. & Vis. Sci, 36, 657--670
[2] Teller et al (1986) Dev. Med. & Child Neuro., 28, 779--789

This work was supported by Fight For Sight [#1353], the NIHR Biomedical Research Centre for Ophthalmology (at Moorfields Eye Hospital and the UCL Institute of Ophthalmology), and the Leverhulme trust

For reprints or further information please email:
p.r.jones@ucl.ac.uk