EFFECTS OF AGE AND BLUR ON, AND TEST-RETEST VARIABILITY OF, A HANDHELD RADIAL SHAPE DEFORMATION TEST

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Purpose
Visual function declines with age, a decline often exacerbated by age-related pathology. However, thresholds for detecting deformation in circular shapes are preserved well in healthy ageing, and might provide a useful approach to detecting pathologies such as age-related macular degeneration (AMD) in older eyes. Wang and colleagues developed a radial shape discrimination test, performance on which was stable in healthy participants up to the fifth decade, after which there was some evidence of decline[1]. More recently they demonstrated that a version of this test presented on an Apple iPod Touch (Handheld Radial Shape Deflection test; HRS), was an effective means of monitoring retinal disease[2]. We investigated the performance of this version of the test in healthy adult participants, and examined test-retest reliability and the effects of blur.

Methods
Participants: 84 healthy participants (52 female), aged 16-60y (meanSD:44±16y), no known retinal or eye problem; normal or corrected to normal visual acuity (VA).

Procedures: Near and distance (VA) measured monocularly using 40cm and 3m ETDRS Logarithmic vision charts.
Contrast sensitivity (CS) tested at 1m using the Pelli Robson Contrast Sensitivity chart.
HRS test: Stimuli were presented on an Apple iPod Touch using a 3APC protocol with a 2-downtick, 1-up staircase procedure [2]. Each stimulus consisted of two undistorted/one distorted “radial frequency” patterns (Figure 1). The position of the distorted pattern and the vertical height of all patterns were randomised between trials. Participants touched the distorted pattern, and were instructed to guess when unsure. Threshold for detecting distortion was recorded as a LogMAR value. In each session the threshold for each eye was recorded twice with the habitual visual correction. Threshold was also measured with blur [induced using convex lenses] equivalent to approximately three LogMAR lines.

Analysis: Data were collated using MS Excel. Each eye was used as the unit of analysis. Data from three amblyopic eyes were excluded from analysis. Bland-Altman analysis was used to examine test-retest reliability and the effects of blur, with parametric statistics where appropriate. Intra-sessional test-retest reliability (using the two thresholds measured in the first testing session) and longer term variability were examined. For 18 participants (mean age:38±16y) data from two sessions (median time between sessions 72.5 days, range 10-169) were available.

Results
The mean (±SD) HRS threshold (84 participants; 165 eyes) was 0.71±0.22; 95% CI: 0.68 to 0.74. When analysed by eye there was a statistically significant correlation with age and the regression line had a positive slope (0.001432; 95% CI: 0.000523 to 0.002712; Figure 2a). Following Wang et al [1], we divided participants into two groups on the basis of age (radially younger participants <60 y) and measured the threshold for the different age groups (Figure 2b). There was no correlation between the age of participants and the HRS threshold difference in the short-term data.

Blur produced a statistically significant increase in mean detect threshold (Figure 2a) from -0.71±1.35 to -0.64±1.9. The mean difference was 0.08±0.17 (t=2.305; 50 degrees of freedom). There was no correlation between the magnitude of the effect of blur and participant age.

Conclusions
Performance on a handheld radial shape deformation (HRS) test is relatively stable in adults in the absence of pathology. There is a slight decline in later decades, similar to that reported for a different version of the same test[1]. Thresholds for the HRS test are uniformly slightly higher than those reported previously.

Performance was relatively stable within and between sessions, although we do not have long-term test-retest data for the oldest participants in our sample. Blur produced a statistically significant alteration in performance; this effect is of little clinical relevance given the expected impact of macular pathology.

References

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Figure 1: example of the radial frequency patterns used as the HRS test stimulus. Threshold was recorded as the radial frequency pattern that the participant was unable to detect or distinguish from the undistorted pattern at the right.

Figure 2: Relationship between age and HRS test performance. Note that in b. the black line indicates the performance reported by Wang et al [1], with the inflection at 60 years.

Table 1: Results of the HRS test.

Figure 3: Scatter plots showing the relationship between HRS threshold (logMAR) and visual acuity (a) and contrast sensitivity (b, d) among the healthy participants. The HRS threshold and visual acuity were significantly correlated at p<0.05. The correlation coefficient for contrast sensitivity was 0.01 in the eyes of the participants.

Figure 4: A: HRS threshold variability of the test before (left), after (right) blur (b) and normal vision (n). All stimuli show results for the two eyes. B: HRS threshold variability difference between the two eyes (diagonal lines). C: HRS threshold variability difference between the two eyes (diagonal lines). D: HRS threshold variability difference between the two eyes (diagonal lines). E: HRS threshold variability difference between the two eyes (diagonal lines).

Figure 5: Result of the paired t-test between the HRS test thresholds measured in the first and second sessions. The y-axis shows the threshold difference between the two test sessions (in LogMAR).