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# Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

## Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

| n/a | Confirmed | |
|---|---|---|
| ☐ | ☒ | The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement |
| ☐ | ☒ | A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| ☐ | ☒ | The statistical test(s) used AND whether they are one- or two-sided<br>*Only common tests should be described solely by name; describe more complex techniques in the Methods section.* |
| ☐ | ☒ | A description of all covariates tested |
| ☒ | ☐ | A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| ☐ | ☒ | A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| ☐ | ☒ | For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted<br>*Give P values as exact values whenever suitable.* |
| ☒ | ☐ | For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| ☒ | ☐ | For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| ☒ | ☐ | Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated |

*Our web collection on statistics for biologists contains articles on many of the points above.*

## Software and code

Policy information about availability of computer code

| | |
|---|---|
| Data collection | We collected raw OCT data and processed it into volumes in real-time using custom software which implemented standard Fourier-domain OCT algorithms. The custom software developed for this research is described in Reference 12. This software is available from the authors upon reasonable request.<br><br>12. M. Draelos, P. Ortiz, R. Qian, C. Viehland, R. McNabb, K. Hauser, A. N. Kuo, J. A. Izatt, Contactless optical coherence tomography of the eyes of freestanding individuals with a robotic scanner. Nat Biomed Eng 5, 726–736 (2021) |
| Data analysis | Thickness measurements from clinical OCT imaging were generated and captured from Heidelberg Software. Thickness measurements for RAOCT was calculated utilizing custom software and is described in Reference 35.<br><br>35. R. P. McNabb, J. Polans, B. Keller, M. Jackson-Atogi, C. L. James, R. R. Vann, J. A. Izatt, A. N. Kuo, Wide-field whole eye OCT system with demonstration of quantitative retinal curvature estimation. Biomed. Opt. Express 10, 338–355 (2019). |

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

## Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

The main data supporting the results in this work are available within the paper. The raw data acquired during the study are available from the corresponding author on reasonable request, subject to approval from the Duke University Health System Institutional Review Board.

## Human research participants

Policy information about studies involving human research participants and Sex and Gender in Research.

| | |
|---|---|
| Reporting on sex and gender | While the primary study design did not consider gender (only healthy or diseased retina), as a secondary analysis we compared retinal thickness as measured by RAOCT and Spectralis for self-identified gender. Table 1 indicates the gender of each image subject and the corresponding measured thicknesses. We found no gender dependent difference in performance for either OCT system. |
| Population characteristics | We imaged 10 patients with healthy retinas and 15 patients with diseased retinas for a total population of 25 (18 female, 9 male; age range: 25-91 years, median age: 46 years; 18 White, 5 Black, 1 Asian-descent). |
| Recruitment | Patients were recruited from the retinal clinics at the Duke Eye Center with our study demographics reflecting those present in clinic. Eligible potential participants were offered enrollment consecutively with equal opportunity to participate. |
| Ethics oversight | Duke University Health System Institutional Review Board |

Note that full information on the approval of the study protocol must also be provided in the manuscript.

# Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

# Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

| | |
|---|---|
| Sample size | We powered our study to detect a pair-wise difference in central foveal thickness of 15 µm between RAOCT and Heidelberg Spectralis in healthy retinas (normal-based 95% CI: mean ± 2SD; power = 90%; α = 0.05). This resulted in a target of 18 eyes with an additional two eyes imaged as 10% overhead (20 eyes). Because we imaged a wide array of diseased retinas, we matched the total number of healthy retinas with an additional 10% imaged (22 eyes). |
| Data exclusions | While all consented patients met the inclusion criteria, individual eyes of some patients could not be imaged with the standard of care clinical OCT (Heidelberg Spectralis) due to motion artifacts from tremor or media opacities, and those datasets were excluded from comparative analysis because there was not a matched pair for comparison between the two modalities (N = 8). |
| Replication | To test for intra-patient foveal thickness measurement variation, we acquired OCT volumes for both modalities in triplicate. In the case of RAOCT, the robot engaged the patient, an OCT volume was captured, and the robot was returned to home position prior to each of the three captured volumes. |
| Randomization | Randomization and control of covariates were not relevant for thickness measurement comparisons because all subjects received the same imaging protocol.<br><br>We performed an additional study comparing the ability of a retinal clinician to diagnose retinas as healthy or diseased between both devices. A total of 25 volumes (one from each subject; 15 diseased, 10 healthy) from each device were graded. Grading was done in two sessions, one week apart with one device graded per session. The order of graded volumes was randomized during each grading session. |
| Blinding | Blinding was not relevant for thickness measurement comparisons because all subjects received the same imaging protocol.<br><br>As noted above in 'Randomization,' we performed an additional study comparing the ability of a retinal clinician to diagnose retinas as healthy or diseased between both devices. The grader was masked to the imaging device and the clinical diagnosis in a given grading session. |

# Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

## Materials & experimental systems

| n/a | Involved in the study |
|---|---|
| ☒ | ☐ Antibodies |
| ☒ | ☐ Eukaryotic cell lines |
| ☒ | ☐ Palaeontology and archaeology |
| ☒ | ☐ Animals and other organisms |
| ☒ | ☐ Clinical data |
| ☒ | ☐ Dual use research of concern |

## Methods

| n/a | Involved in the study |
|---|---|
| ☒ | ☐ ChIP-seq |
| ☒ | ☐ Flow cytometry |
| ☒ | ☐ MRI-based neuroimaging |