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**Citation:** Montesano, G., Nathwani, N., Yu, J., Kong, Y. X. G., Vingrys, A., Gazzard, G. & Jayaram, H. (2026). Fields from home: device-independent online perimetry with Melbourne Rapid Fields. British Journal of Ophthalmology, doi: 10.1136/bjo-2025-328016

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**Link to published version:** <https://doi.org/10.1136/bjo-2025-328016>

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**Title:** Fields from Home: Device Independent Online Perimetry with Melbourne Rapid Fields

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**Keywords:** Glaucoma, Home Monitoring, Telemedicine, Perimetry, Visual Field

**Running Title:** Device Independent Online MRF Perimetry

**Synopsis/Précis:** Home-based visual field testing is more variable than in-clinic testing, but a higher testing frequency enables similar or earlier detection of disease progression. Most participants preferred home testing for its convenience.

**Acknowledgments:**

This project was supported by the Moorfields Eye Charity (GR001214). HJ & GM are employed by Moorfields Eye Hospital NHS Foundation Trust. GG is employed by UCL and has been supported by grants from the National Institute for Health Research (HTA 09/104/40), Moorfields Eye Charity, British Council to Prevent Blindness, Fight For Sight and the International Glaucoma Association. GG & HJ are grateful to the support of the National Institute for Health Research Biomedical Research Centre for Ophthalmology at Moorfields Eye Hospital and the UCL Institute of Ophthalmology. The views expressed in this paper are those of the authors and not necessarily those of any funding body or the Department of Health.

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## Structured Abstract

### Aims:

To assess the short-term reliability and agreement of home-based visual field testing using web-based Melbourne Rapid Fields (MRF-web) software compared to standard in-clinic Humphrey Field Analyzer (HFA) perimetry. To evaluate the feasibility and patient acceptance of home visual field (VF) monitoring and whether increased testing frequency with home monitoring could detect progression earlier.

### Methods:

Cross-sectional study with a repeated measures design of one eye of 100 adult participants from the LiGHT trial with stable VFs with a questionnaire capturing participant feedback. Participants performed VF tests at home using MRF-web on their own computers. Each testing session included visual acuity, two 10-2 VFs, and two 24-2 VFs. Analysis compared the MRF 24-2 with two most recent HFA 24-2 from prior clinic visits. Bland-Altman plots and mixed linear models assessed test-retest variability and agreement, while simulations estimated the power to detect progression. Patient feedback was collected via online questionnaire.

### Results:

MRF-web showed greater test-retest variability than HFA for point-wise values, with a significant learning effect. There was a significant proportional bias, with MRF underestimating damage compared to HFA. The standard error for MTD progression was higher for MRF at a 6-month testing interval. 4-monthly MRF testing achieved similar progression detection power to 6-monthly HFA: more frequent testing enabling earlier detection of progression. Most participants preferred home monitoring due to convenience.

### Conclusions:

Home-perimetry produced more variable results than in-clinic testing but the increased testing frequency made possible achieves similar, and potentially earlier progression detection to standard in-clinic testing.

## **Key Messages**

### **What is already known on this topic:**

Telemedicine monitoring of visual fields is an emerging and novel management approach in glaucoma care, which could provide clinicians with supplementary information captured between scheduled outpatient assessments. This currently requires purpose built equipment which limits the accessibility of this approach to the wider patient population.

### **What this study adds:**

Home visual field tests comparable to those performed in a hospital setting can be performed on patients own home computers without the need to purchase additional hardware. Modelling demonstrates that earlier detection of glaucoma progression can be achieved with more frequent home testing which can supplement in-clinic testing.

### **How this study might affect research, practice or policy:**

This study offers proof of principle for the wider accessibility of home visual field testing for any patient with a home computer. This will enable future research evaluating the feasibility of implementation and integration of this technology into standard clinical care pathways for glaucoma, with the aim of improving clinical outcomes through the earlier detection of disease progression.

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## **Introduction**

Glaucoma is the leading cause of irreversible worldwide blindness characterised by the progressive loss of retinal ganglion cells, with intraocular pressure lowering being the only current modifiable risk factor borne out by large scale clinical trials.[1] Affected individuals are burdened with frequent hospital visits for monitoring using visual field testing and optic nerve imaging performed to identify disease progression[2] and to receive tailored medical intervention(s) to reduce the risk of potentially irreversible sight loss. The need for frequent review places strains on healthcare systems often resulting in lengthy waiting lists.[3 4] Furthermore, a proportion of patients with glaucoma experience vision loss due to delayed or cancelled follow-up appointments.[5] At the same time, it has been recognised that the majority of patients in glaucoma clinics can be considered at low risk for sight loss and may be more appropriately managed with alternative and more efficient models of care.[6]

Telemedicine (TM) for vision monitoring is an emerging and novel management approach which could potentially address some of the shortcomings of standard in-clinic testing with computerized perimeters by providing clinicians with supplementary information on a patient's disease status between scheduled clinical reviews. It also reduces the prospect of cross contamination during future pandemics as patients can use their own equipment.

Modelling suggests that clinical progression can be detected earlier with more frequent TM tests compared to standard six monthly clinic-based visits.[7] Several options for TM for glaucoma are available, such as using virtual reality-based headsets,[8-10] however these require adoption of purpose-built equipment. One alternative technology, is tablet-based perimetry,[11] such as the Melbourne Rapid Fields-glaucoma iPad application (MRF, Glance Optical Pty. Ltd., Melbourne, Australia)[12 13] and the Eyecatcher.[14 15] Tablet technology has the benefit that it can provide a more familiar environment to patients than virtual reality goggles given the ubiquity of tablet devices amongst the wider population and the fact that many older patients may own such devices or be able to borrow them from relatives or friends.[16]

Previous studies have shown that TM visual field testing (TM-VF) with iPad based MRF has excellent short term uptake and compliance by patients with glaucoma in the short term.[17] These studies involved patients being given a dedicated device with pre-installed software which restricts access to wider patient populations due to both practical and financial constraints. During COVID-19 pandemic, there was a need for clinics and clinical trials to monitor the vision of a larger number of glaucoma patients reducing the number of physical attendances. This gave rise to the translation of MRF software that allowed device-agnostic testing from a web browser.

Here we report outcomes for a short-term longitudinal study using the web-browser based version of the MRF software (MRF-web) which has been designed to function on flat screen devices after a simple screen calibration step (requires 246 mm (9.7 inch) monitor or larger). Patients previously enrolled in the LiGHT trial[18] were recruited in this study to perform a series of visual field (VF) tests at home using their own computer device. The test results were compared with their recent SITA 24-2 Standard perimetry obtained from clinical practice using a HFA in terms of agreement and repeatability. Simulations were used to evaluate the impact of home monitoring with MRF-web upon the detection of VF deterioration compared to current standard care.

## **Materials and Methods**

### **Study Design and Participants**

One-hundred patients were recruited into this cross-sectional study. All patients had previously participated in the Laser in Glaucoma and Ocular Hypertension (LiGHT) Trial at Moorfields Eye Hospital, London. The details of the baseline characteristics from this study are described elsewhere.[18] Eligible participants were

aged 18 years or older with no upper age limit. Participants had previously given informed consent to be approached about inclusion in future research studies. Participants had visual acuity of 6/18 or better in the study eye and it was required the patients had been shown to have stable and reliable visual fields in one eye over the prior 1 year of follow up, as judged by a glaucoma specialist. Participants were able to give informed consent and understood spoken and written English language. They were also required to possess a home personal or laptop computer with internet access. The study was approved by the London – Bromley NHS Research Ethics committee (Ref: 20/HRA/2645).

The study employed a repeated measures design to evaluate participants' visual field using the MRF-web software. Participants were requested to undertake two 5-test series one week apart and which all participants completed. Each test series consisted of a visual acuity test, two 10-2 field tests, and two 24-2 field tests, taking approximately 20 minutes in total to complete. To minimize the impact of any testing bias, the order of the two types of field test performed in each testing series was selected at random. Only the testing data for the 24-2 MRF test results (excluding the one training test) was used for analysis.

Validation of MRF software has previously been published elsewhere and is summarised in the supplementary appendix.[19 20]

Following informed consent, participants were recruited into the study (Day 0). The following day (Day 1), participants were asked to perform a practice/training test on the chosen study eye. Participants were provided with both written instructions and instructions on the phone by a research assistant to facilitate training. This training included how to access the website ([www.visioninhome.uk](http://www.visioninhome.uk)), how to complete the calibration steps ensuring correct viewing distance and how to complete and save tests. Once training had been completed, participants conducted the first phase of testing (Day 2). Participants then took a break from testing for a minimum of 7 days before completing the second phase of testing (Day 9 or later) to assess repeatability. Participants finally completed a user feedback questionnaire to complete the study.

The participants' two most recent HFA 24-2 tests prior to study enrolment were extracted from the Moorfields Electronic Medical Record. Patients were required to have a stable visual field in the study eye over one year of prior follow up. This was chosen as the control, due to its established role as the “gold standard” for monitoring visual fields in clinical glaucoma practice. All participants were experienced with perimetry (HFA) testing.

## **Data Analysis**

For fairness of comparison, we analyzed the 52 locations from the standard 24-2 grid, common to the two tests. It is useful to note that the test performed with the MRF contains four additional locations 0.8 degrees from fixation. Moreover, for both HFA and MRF, we calculated a summary metric using the mean of the total deviation (TD) values (MTD). This is similar to the HFA mean deviation but does not use correction factors for eccentricity.[21] Age-related total deviation values were provided by the manufacturer for MRF and extracted from the printouts for the HFA. False positive rate (FP) was the only metric used to assess reliability ( $\leq 15\%$ ), as this has shown to be the most relevant in clinical perimetry.[22] However, because HFA tests were retrospectively obtained from clinic rather than being part of the prospective data collection, we allowed a higher threshold for FP to deem them acceptable for inclusion ( $\leq 30\%$ ).

## **Test-Retest Variability**

Long-term test-retest variability was analyzed for point-wise (sensitivity and TD) and global metrics (MTD). We calculated Bland-Altman plots[23] by taking the average and the difference between the two repetitions of the test (Test 2 - Test 1), discarding the practice session. We used bootstrap (1000 re-samples) to estimate the 95%-Confidence Intervals (95%-CIs) around the 95%-Limits of Repeatability (95%-LoRs). For point-wise data, the re-sampling unit was the eye, meaning that all point-wise data from test-retest pairs were re-sampled together, to preserve correlations. Variability in perimetry is known to vary with

sensitivity,[24] however the comparison is made valid by comparing tests obtained on the same individual. The test-retest 95%-LoR-range was also compared. Note that, differently from the 95%-LoRs, their overall range is not affected by bias, eg. systematic differences from learning effects between the first and second repeat.

The effect of learning was quantified with the test-retest bias in the Bland-Altman analysis and by comparing the progressive change in MTD for MRF between the practice test and the two test-retest sessions using a linear mixed effect model, with the eye as the grouping factor and the testing session as a categorical fixed effect.

### **Between Test Agreement**

Agreement between the two tests was also assessed. However, because there could be systematic differences between the two tests, we calculated the proportional bias by fitting a linear model. The 95%-Limits of Agreement (95%-LoAs) were calculated on the residual variance after accounting for proportional bias. Note that LoAs are calculated identically to the LoR but for agreement rather than test-retest data. The equation for the proportional bias included random effects for the TD values, to account for multiple measurements (i.e. various locations within the test) performed on the same eye. The residuals, in this case, were calculated from the fixed effect predictions. Agreement was assessed only for deviation metrics, since the MRF and HFA use different durations and stimulus sizes[12 13] and sensitivity cannot be directly compared. Linear calibration equations to transform HFA deviation values from HFA to MRF were also calculated. For TD values, random effects were used, similarly to the calculation of the proportional bias.

### **Estimated Power to Detect Progression**

To evaluate the real-life implications of home monitoring with MRF compared to standard clinical practice, we calculated the standard error (SE) of the linear regression slope for the MTD based on the test-retest variance of each instrument over a period of 5 years and increasing frequency of testing for MRF. We used the estimated SE to calculate the power to detect a significant MTD progression using standard linear regression (i.e., negative slope with one-sided  $p < 0.05$  using a t-test on the slope coefficient). The objective was to calculate what frequency of home-monitoring tests would give a detection power equivalent to 6-monthly HFA testing. The test-retest variance was calculated with two separate random effect models (one for each device), with the patient/eye as the grouping factor. This calculation did not account for changes in variability with increasing damage but still offers a valid comparison because the same subjects were tested with both devices.

### **Home Monitoring User Feedback Questionnaire**

Following completion of the home monitoring session, participants were asked to complete a user feedback questionnaire, which was to be administered anonymously online (using [www.surveymonkey.com](http://www.surveymonkey.com)). Participant responses were provided either on a Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree), or on a linear scale (ranging 0-100). All participants who completed the home visual field monitoring study, went on to complete the online questionnaire. The questionnaire asked the patients to rate their experience with in-clinic and at-home testing.

## **Results**

### **Patient Demographics**

One hundred patients were recruited and 96 returned four reliable tests (unreliable: two HFA and two MRF tests) and were included in the analysis. Participants had a Median [Interquartile range] age of 67 [59, 73] years and a spherical equivalent near correction of +2.12 [+0.44, +3.25] dioptres. Only 2/198 HFA tests had FP > 15% but <30%. The interval between the two tests (Median [Interquartile Range]) was 6.3 [4.4, 9.0]

months for HFA and 1.28 [1.14, 1.86] weeks for MRF. Additional test-specific descriptive statistics are listed in Table 1. Our participants had early to moderate defects as evident by the HFA MD values in Table 1.

### Test-Retest Variability

The Bland-Altman plots in Figure 1 report the test-retest variability for HFA and MRF for sensitivity, TD and MTD values. For point-wise values, the 95%-LoR were noticeably larger for the MRF performed unsupervised at home compared to the HFA. Of note, there was a significant positive bias for the MRF, indicative of a learning effect ( $p = 0.044$ ). Both the superior and inferior 95%-LoRs and their range were significantly different between HFA and MRF. Note that the 95%-LoR range is not affected by bias. Table 2 reports numerical values and 95%-confidence intervals (95%-CIs). No significant differences were found for the 95%-LoRs and range for the MTD. The MTD bias was not significant for the MRF ( $p = 0.062$ ). In general, the 95%-LoRs were difficult to characterize for the MRF because of the large effect that a few outliers had on that data, which increased its variability, leading to much larger 95%-CIs compared to the HFA.

There was significant average improvement in the MTD between the practice and test-retest sessions, (Supplementary Material).

### Test Agreement

The agreement between the two devices was assessed by performing all pairwise comparisons between test repetitions (Figure 2). Both the point-wise and global metrics showed a significant proportional bias (all  $p < 0.001$ ), with the estimates from the MRF being systematically lower than HFA for more damaged fields. This likely reflects the different test spot sizes used by the MRF. The calibration equation was  $MRF(dB) = 1.27 + 0.92 * HFA(dB)$  for MTD and  $MRF(dB) = -0.97 + 0.41 * HFA(dB)$  for point-wise TD (fixed effect coefficients).

### Estimated Precision to Detect Progression

Given the larger variability found for the MRF data when tested unsupervised at home, the SE on the slope estimate of MTD progression over time was larger (1.4 times) for MRF than HFA using a common 6-month testing interval (standard of care). This led to an estimated lower power to detect progression (**Figure 3**). However, increasing the frequency of testing reduces the SE for MRF. The detection power obtained with 6-monthly HFA tests was close to that achieved by MRF testing with of 4-monthly intervals, with better power to detect progression earlier with more frequent testing schedules. In general, the power of 6-monthly HFA testing was comparable to 2-monthly and 4-monthly testing with MRF.

### Home Monitoring User Feedback Questionnaire

The results of the questionnaire are reported as supplementary material.

### Discussion

In this study, we report on short-term home-based visual field testing in a large cohort of the LiGHT trial participants using a web-based application (MRF-web) on patients' personal home computers. We compared the correlation and test-retest variability between MRF-web obtained unassisted at home and the HFA obtained in clinic.

MRF outputs display larger test-retest variability compared to HFA, although the 95%-LoAs were not significantly different between the two tests for the MTD, an approximation of the MD. This has important consequences for clinical detection of progression, mainly limiting detection to larger losses if a single test is used or requiring an increased testing frequency with the MRF device to yield detection of similar or

smaller losses at an earlier timepoint. Figure 3 shows that 2-monthly MRF testing is predicted to detect a statistically significant VF decline better than routine 6-monthly HFA review. For faster rates of progression, 4-monthly MRF is predicted to have a detection power close to 6-monthly HFA. A more intensive testing schedule would also allow earlier detection of VF deterioration.

It is important to notice that there are intrinsic differences between the two tests that complicate direct comparison. The MRF test was performed, for this study, using commercial personal computer screens in the patients' homes. This imposes limitations on the control over room illumination, maximum screen brightness and dynamic range of the device[19]. Moreover, the HFA and MRF use different thresholding algorithms (SITA[25] and ZEST[26] respectively). The implementation of ZEST used in the MRF adopts a 3-step sampling method of 7 contrast levels over a 30 dB range, compared to 30 steps in the HFA over the same range[13]. The different testing strategies and dynamic range explain the patterns of test-retest variability observed in Figure 1, where the larger testing steps are likely the cause for the larger point-wise test-retest variability. It should also be noted that the stimuli used by MRF differ from the HFA in terms of duration (300 ms for MRF, 200 ms for HFA) and size[13]. The MRF scales its stimuli with eccentricity[27], flattening the usual 'hill of vision' obtained with a Goldmann III stimulus size[13]. We partially accounted for these differences by comparing only relative loss compared to normative values (TD) for both devices, but this cannot eliminate all the intrinsic differences in stimulus characteristics. Despite this, the MTD, an average of the TD values, was in good agreement between MRF and HFA, with a slope of the calibration equation very close to unity (0.91 [0.71, 1.12], Estimate [95%-CIs]). However, all the agreement plots (**Figure 2**) show a significant proportional bias in both the MTD and pointwise TD, with consistently more negative estimates of VF damage from MRF for more advanced VF loss. This likely arises from the differences in spot size and indicates that, despite having similar MTDs, the two test metrics cannot be directly compared. For completeness, a direct comparison of the metrics as provided by the two devices (i.e. the device-specific MD and PSD) is reported as supplementary material (**Supplementary Material**).

The test-retest variability was clearly larger for MRF performed unsupervised at home compared to HFA when performed in the clinic with supervision. This was particularly apparent for the pointwise data. The difference in 95%-LoAs failed to reach significance for the MTD. However, this is likely due to the two-tailed testing and the large variability in the estimate of the limits for MRF. Many factors could have contributed to this, including the less controlled testing environment and learning how to interface with the MRF computer software. We took care to reduce learning as much as possible, via preliminary practice tests, but learning is known to extend for up to 6 tests in glaucoma patients[28] and cannot be excluded when the test is performed with a new device[29]. This was demonstrated by the analysis reported as Supplementary Material, which shows the progressive increase in MRF MTD over the first three tests, especially compared to the practice test. Indeed, when tested in a different home monitoring setting, patients who were already trained on the HFA required, on average, 9 tests before their MRF MD came close to the HFA MD measured in the clinic[30], with minor improvement continuing even in later tests. However, we did not observe any significant bias in the MTD test-retest differences for MRF or HFA, which would be a sign of a strong learning effect between sessions[28 29]. Of note, other groups report a significant learning effect in experienced visual field takers[20] but previous comparisons between MRF and HFA showed much better agreement between the two devices and better test-retest variability for MRF when undertaken with clinical supervision.[12] One possible difference was that previous investigations used a standardized testing device and patients received in-clinic training prior to testing (iPad, Apple, Cupertino, CA, USA)[12 30] and this might explain the discrepancy with our results.

A potential advantage of the application of home monitoring as an adjunct to routine care is the possibility of allowing earlier detection of VF progression[7] through an increased frequency of testing. With our data, the larger test-retest variability for MRF had an impact on the estimated SE of the progression slope in our calculations, an indicator of the precision of the estimate obtained with either device (lower SE indicating higher precision). We determined that the precision of the estimates obtained with 2-monthly MRF testing

was better than 6-monthly HFA tests. A similar predicted frequency of progression detection was achieved for fast progression with 4-monthly MRF (**Figure 3**). We should emphasize that this difference is likely to reduce with more training[30] and that the results would be different with the MRF variability estimated in previous cohorts[12]. Importantly, this leaves room for further improvement in precision with monthly or weekly testing, which would not be feasible in a standard clinical setting, and would reduce the gaps between tests, potentially allowing earlier detection of progression, even at the same level of precision as HFA (**Figure 3**).

Home monitoring could also facilitate other approaches to facilitate the detection of progression, such as test clustering[31 32]. It should also be noted that, in this analysis, the test-retest variability of MRF was compared with that of SITA Standard tests. Many clinics, however, employ faster strategies, such as SITA Fast or Faster[32], which are known to have a larger test-retest variability[24].

In general, the acceptance of the MRF home-monitoring test was similar to in-clinic testing, with a larger proportion of patients finding it easier to concentrate during home-monitoring sessions than in-clinic. However, the understanding of the test requirements was slightly lower than in-clinic testing, and this is likely due to the higher complexity of setting up and executing the test without the assistance of a technician. These aspects should be considered when deploying home monitoring on a larger scale, also in consideration of the fact that this sample was particularly familiar with VF testing. Nevertheless, most patients recognised the convenience of not having to travel to clinics and choosing their preferred time for testing as advantages of home-monitoring.

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### **Contributorship Statement**

GM: data analysis, drafting of manuscript, revision and approval of final manuscript; NN, JY: collection of patient data, data analysis, revision and approval of final manuscript; YXGK, AJV: development of research protocol, provision of materials/software, revision and approval of final manuscript; GG: conception & design, development of research protocol, revision and approval of final manuscript; HJ: conception & design, development of research protocol, acquisition of funding, revision and approval of final manuscript. HJ will act as guarantor for the work and accepts full responsibility for the finished work, the conduct of the study, had access to the data and controlled the decision to publish.

### **Funding/Support**

This project was supported by the Moorfields Eye Charity (GR001214). HJ & GM are employed by Moorfields Eye Hospital NHS Foundation Trust. GG is employed by UCL and has been supported by grants from the National Institute for Health Research (HTA 09/104/40), Moorfields Eye Charity, British Council to Prevent Blindness, Fight For Sight and the International Glaucoma Association. GG & HJ are grateful to the support of the National Institute for Health Research Biomedical Research Centre for Ophthalmology at Moorfields Eye Hospital and the UCL Institute of Ophthalmology. The views expressed in this paper are those of the authors and not necessarily those of any funding body or the Department of Health. Access to the Melbourne Rapid Fields Software web portal was kindly provided by GLANCE Optical Pty Ltd.

### **Competing Interests**

Financial Disclosures: GM (Consulting fees: Omikron, Alcon, Laboratoires Théa, Centervue, Enavate, Dompé, Astellas, Perfuse Therapeutics), NN (None), JY (Consulting Fees: Alcon), YXGK (Shares: GLANCE Optical, Consulting Fees: Glaukos, Abbvie), AJV (Shares: Glance Optical), GG (consulting fees: Alcon Laboratories, Allergan/Abbvie, Balance Ophthalmics, Bausch & Lomb, Belkin Vision, Cilitech, Elios Vision, Essential Pharma, Eyetronic, Genentech/Roche, Glaukos, Haag-Streit Group, Iantrek, iStar Medical, Ivantis, Lumenis, McKinsey, Nova EyeMedical, Oertli, Quantel/Ellex Lumibird, Rayner Ltd, Reichert, Ripple Therapeutics, Santen, Sight Sciences, Thea, Topcon, Vialase, Visufarma, Zeiss ), HJ (Consulting Fees: Abbvie, Alcon, Scope Ophthalmics; Lecture Fees: Alcon, Scope Ophthalmics, Laboratoires Théa, Santen, Visufarma; Research Grants: Santen; Stock Options: Rebio, Finland)

### **Data Availability Statement**

Data are available upon reasonable request. HJ had full access to all study data and takes responsibility for the integrity of the data and the accuracy of the data analysis.

### **Ethics Statement**

The study involved human participants. The study was reviewed and approved by the London – Bromley NHS Research Ethics committee (Ref: 20/HRA/2645) and was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all study participants.

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### **Captions For Figures**

**Figure 1.** Bland-Altman plots for point-wise and global metrics. The grey shaded area represents the 95%-Limits of Repeatability. The blue shaded area and the dashed lines indicate their 95%-Confidence Intervals, calculated via bootstrap.

**Figure 2.** Agreement between tests for point-wise and global metrics. The dashed lines indicate the 95% limits of agreement (95%-LoA), calculated as the 95% quantiles of the residuals from the bias equation. Both the 95%-LoAs and the bias equations are reported in the graphs.

**Figure 3.** Power to detect significant progression (one-sided  $p < 0.05$  of worsening on linear trend of MTD) estimated using the variability from the test-retest data, starting at one year (when at least 3 tests would have been collected for all conditions). The colour code indicates the frequency of testing. The plot titles report the assumed rate of progression. Equivalence to HFA was achieved with 4-monthly MRF tests for fast progression. MRF with 2-monthly testing was superior to 6-monthly HFA. HFA = Humphrey Field Analyzer; MRF = Melbourne Rapid Fields; MTD = Mean Total Deviation.

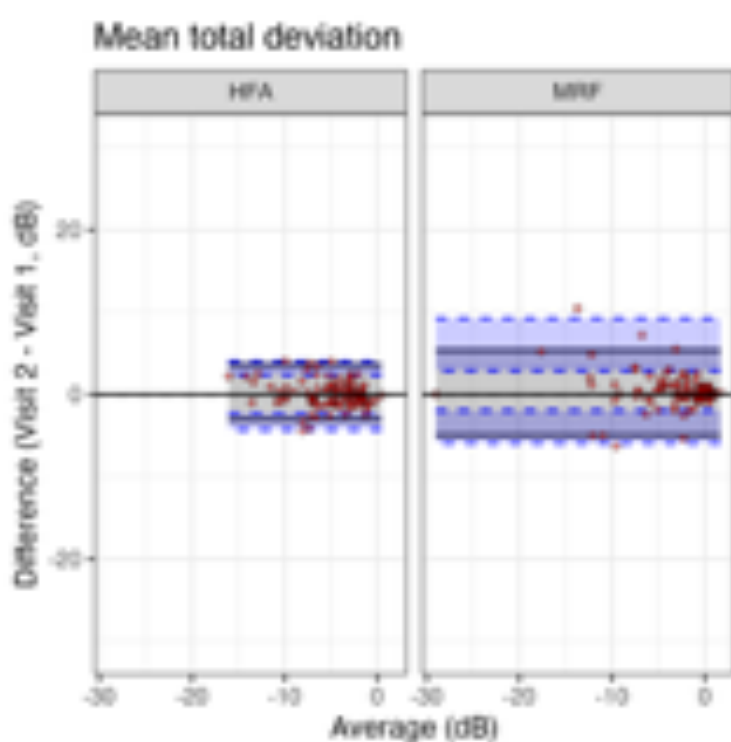
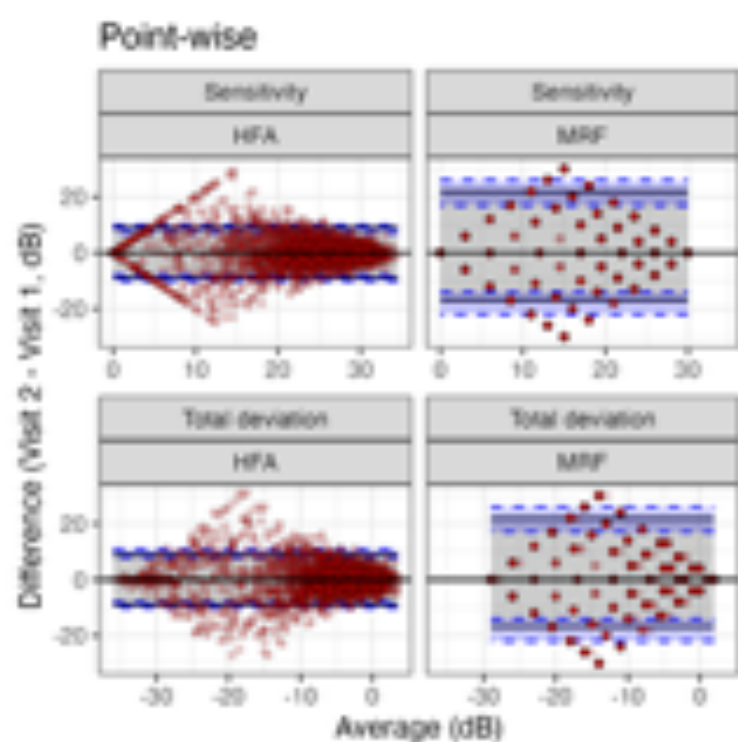
## Tables

|                        | HFA                |                      | MRF                   |                       |
|------------------------|--------------------|----------------------|-----------------------|-----------------------|
|                        | Test 1             | Test 2               | Test 1                | Test 2                |
| <b>MD (dB)</b>         | -4.35 [-6.6, -2.4] | -4.38 [-7.23, -2.35] | -2.58 [-7.24, -0.72]  | -2.13 [-5.77, -0.61]  |
| <b>PSD (dB)</b>        | 3.97 [2.68, 8.34]  | 4.26 [2.57, 7.65]    | 4.94 [2.6, 8.53]      | 5.56 [2.35, 8.52]     |
| <b>FP (%)</b>          | 2 [0, 3]           | 1 [0, 3]             | 0 [0, 0] <sup>1</sup> | 0 [0, 0] <sup>2</sup> |
| <b>FN (%)</b>          | 1 [0, 6]           | 1 [0, 7]             | 0 [0, 0] <sup>3</sup> | 0 [0, 0] <sup>4</sup> |
| <b>Duration (mins)</b> | 5.80 [5.08, 6.30]  | 5.43 [4.98, 6.20]    | 4.03 [3.71, 4.58]     | 3.96 [3.55, 4.42]     |

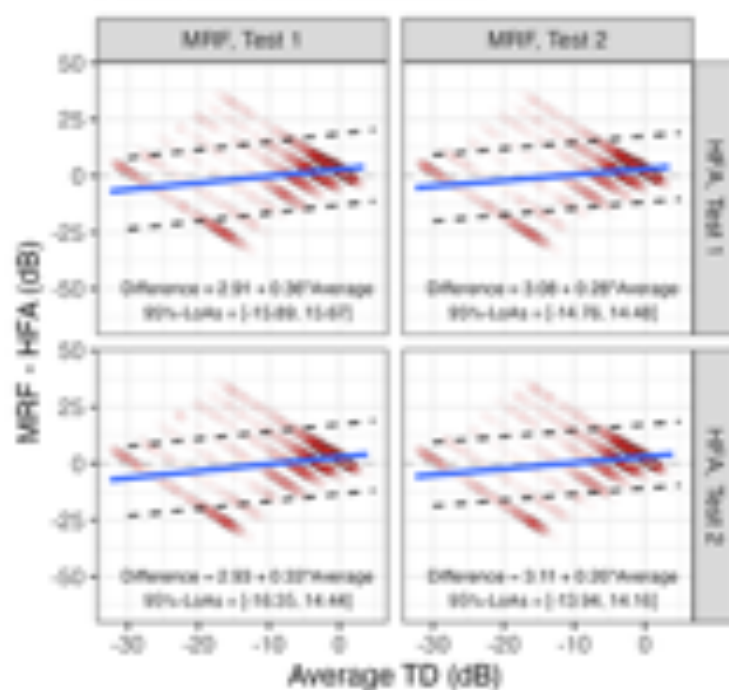
**Table 1.** Descriptive statistics (reported as Median [Interquartile range]) for the two test repetitions for HFA and MRF. Note that all the metrics are listed as provided by the manufacturers. Importantly, the MD listed here is different from the Mean Total Deviation used for analysis (see Methods). HFA = Humphrey Field Analyzer; MRF = Melbourne Rapid Fields; MD = Mean Deviation; PSD = Pattern Standard Deviation/Pattern Deviation; FP = False Positive; FN = False Negative. <sup>1</sup>14 tests with FP > 0%; <sup>2</sup>10 tests with FP > 0%; <sup>3</sup>18 tests with FN > 0%; <sup>4</sup>11 with FN tests > 0%.

|                        |                         | HFA (Sensitivity)   | MRF (Sensitivity)    | <i>p</i>          |
|------------------------|-------------------------|---------------------|----------------------|-------------------|
| <b>Sensitivity</b>     | <b>Bias</b>             | -0.02 [0.29, -0.36] | 0.43 [0.84, 0.01]    |                   |
|                        | <b>Superior 95%-LoR</b> | 9 [10, 7.22]        | 22 [26, 17]          | <b>&lt; 0.001</b> |
|                        | <b>Inferior 95%-LoR</b> | -9 [-8, -10]        | -17 [-14, -22]       | <b>&lt; 0.001</b> |
|                        | <b>Range</b>            | 18 [16, 19.24]      | 39 [32.44, 48]       | <b>&lt; 0.001</b> |
| <b>Total deviation</b> | <b>Bias</b>             | -0.02 [0.29, -0.36] | 0.43 [0.84, 0.01]    |                   |
|                        | <b>Superior 95%-LoR</b> | 9 [11, 8]           | 22 [26, 17]          | <b>&lt; 0.001</b> |
|                        | <b>Inferior 95%-LoR</b> | -9 [-8, -10]        | -17 [-14, -22]       | <b>&lt; 0.001</b> |
|                        | <b>Range</b>            | 18 [16, 20]         | 39 [32.44, 48]       | <b>&lt; 0.001</b> |
| <b>Mean deviation</b>  | <b>Bias</b>             | -0.02 [0.31, -0.35] | 0.43 [0.88, -0.02]   |                   |
|                        | <b>Superior 95%-LoR</b> | 3.64 [4, 2.35]      | 5.37 [9.2, 2.85]     | 0.254             |
|                        | <b>Inferior 95%-LoR</b> | -3.11 [-2.27, -4.3] | -5.02 [-1.96, -5.94] | 0.158             |
|                        | <b>Range</b>            | 6.75 [4.97, 8.11]   | 10.39 [6.12, 14.53]  | 0.100             |

**Table 2.** Bias, Limits of Repeatability (LoR) and test-retest range for point-wise and global metrics. The *p*-values are for the differences between the two devices. Significant findings are highlighted in bold. HFA = Humphrey Field Analyzer; MRF = Melbourne Rapid Fields.



Point-wise total deviation



Mean total deviation

