What Reduction in White-on-White Perimetry Variability Would Improve the Detection of Visual Field Progression?

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Background

Reliably detecting glaucomatous progression using current white-on-white perimetric methods **(SAP) often takes upwards of eight visual field tests**. In this study we used computer modeling to quantify the decrease in variability required in current techniques that would lead to detection of progression in fewer visits.

Methods

The variability of threshold estimates of a true threshold t was modeled as a Gaussian fitted to 10,000 applications of the Full Threshold algorithm to a patient with false response rates of 1%, and a psychometric slope as described in Henson et al [1]. **Figure 1** shows that this model accurately reproduces known test-retest data of SITA [2]. Improved perimetric procedures were simulated by reducing the standard deviation of the fitted Gaussian in steps of 10% from the original.

We classified progression in two ways: pointwise linear regression (PLR) on individual locations, and linear regression on Mean Defect (MD) (data not shown on this poster, see third reference). Both techniques used criteria that had 95% specificity at all time periods determined by simulation of 1000 subjects stable at 30dB.

Results

Figure 2 shows the number of years of testing required to achieve various true-positive rates at 95% specificity (true negative rate) using PLR on locations beginning at 30 dB, with testing either twice or thrice per year. More comprehensive data is included in our related paper (to appear, currently online [3]).

Figure 3 shows the standard deviation of a Gaussian that models error for various procedures other than those used to generate Figures 1 and 2. The ZEST procedures are those we have used previously in related work [4].

Conclusions

Progression of 1 dB per year can be detected 2 to 3 visits earlier using a procedure with 40% less variability than current procedures.

It is unlikely new testing algorithms combined with Size III white-on-white targets alone can create the reduction in variability required: alternate stimuli may be required.

The methods adopted in this paper can be applied to analyze new perimetric techniques prior to lengthy and expensive clinical trials in order to determine their utility for classifying progression.

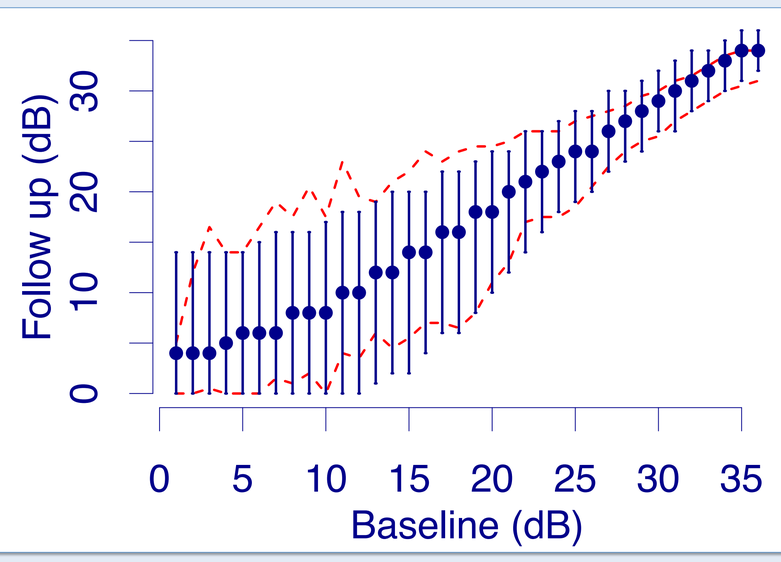

Figure 1: Test-retest data using our Gaussian error model: • is mean, – is 95% CI; and SITA data from Artes et al: – is 95% CI.

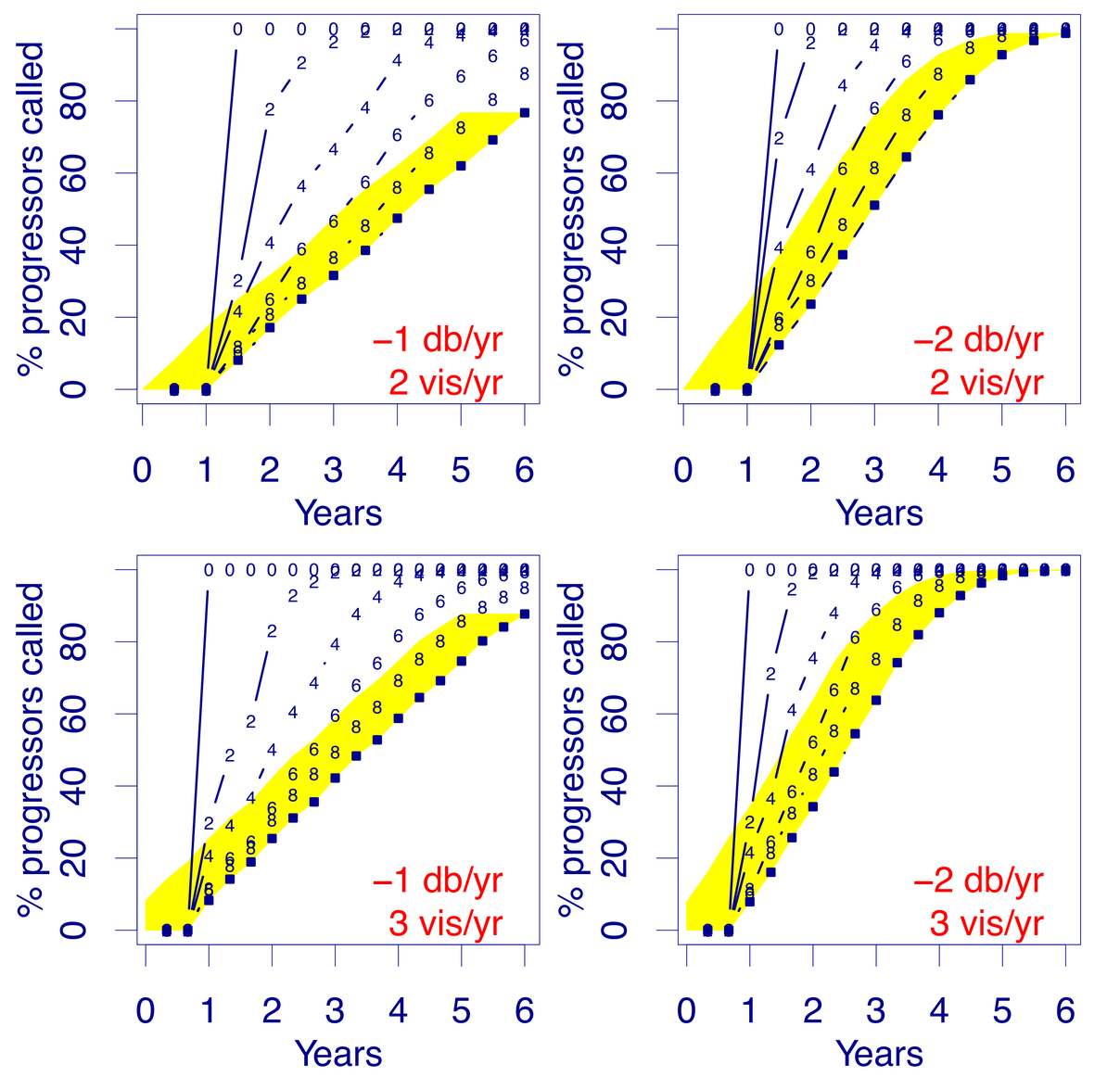

Figure 2: Time taken to detect progression (x-axis) for a given sensitivity (y-axis) using pointwise linear regression for a location beginning at 30 dB and decreasing as indicated in the red text in the bottom right corner of each panel. The number x on each curve indicates visual field data from a simulated procedure with x*10% error of current white-on-white procedures (shown as the ■). The yellow area highlights one year less than current.

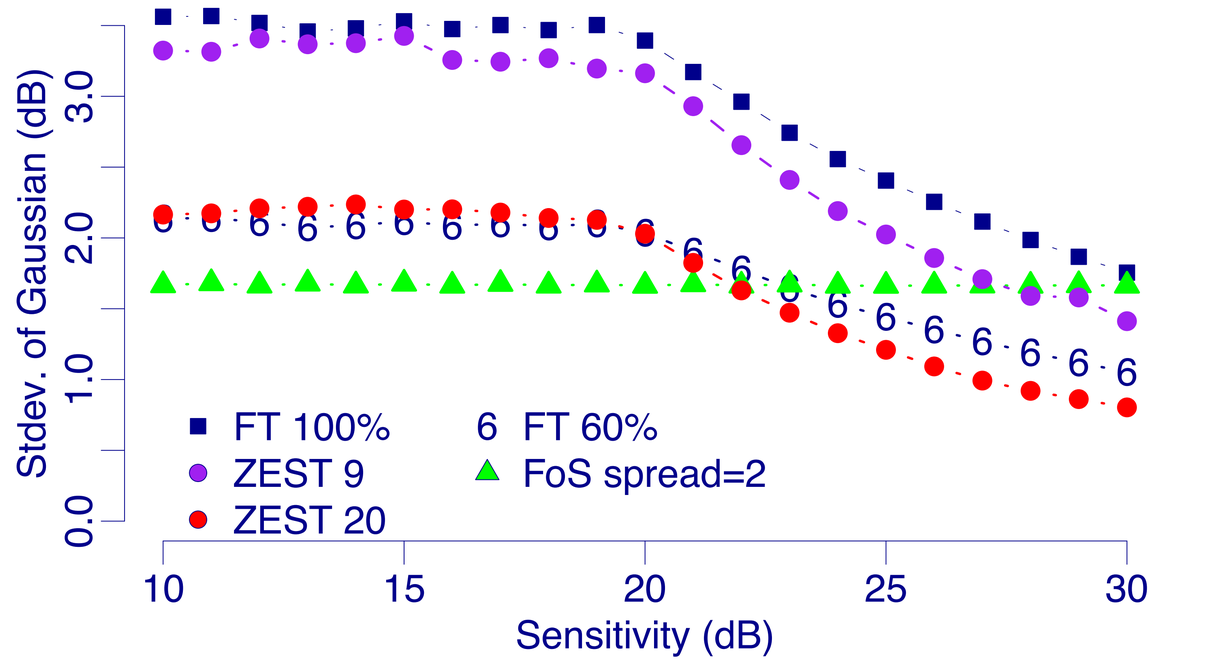

Figure 3: Error of different procedures. ■ and 6 are from Figure 2. • and • are ZEST procedures we have used in our other work running for a mean of 9 and 20 presentations. The green triangles represent a theoretical perimetric procedure that has a consistent variability across all threshold levels (that is, not white-on-white Size III targets).

References

[1] Henson et al, *Response Variability in the Visual Field: Comparison of Optic Neuritis, Glaucoma, Ocular Hypertension, and Normal Eyes*. Investigative Ophthalmology & Visual Science, February 2000, Vol. 41, No. 2.

[2] Artes et al, *Properties of Perimetric Threshold Estimates from Full Threshold, SITA Standard, and SITA Fast Strategies*. Investigative Ophthalmology & Visual Science, August 2002, Vol. 43, No. 8.

[3] Turpin & McKendrick, *What reduction in Standard Automated Perimetry variability would improve the detection of visual field progression?*, published online before print IOVS, 2011. doi: 10.1167/iovs.10-6255.

[4] Turpin et al, *Properties of perimetric threshold estimates from Full Threshold, ZEST and Sita-like strategies as determined by computer simulation*. Investigative Ophthalmology & Visual Science, November 2003, Vol. 44, No. 11.

Acknowledgements

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