Between-Algorithm, Between-Individual Differences in Normal Perimetric Sensitivity: Full Threshold, FASTPAC, and SITA

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PURPOSE. To determine the between-algorithm differences in perimetric sensitivity for the Swedish Interactive Threshold algorithm (SITA) Standard, SITA Fast, FASTPAC, and Full Threshold algorithms; to determine the between-subject, between-algorithm differences in the magnitude of the normal variation in sensitivity.

METHODS. The sample comprised 50 normal subjects (mean age, 52.9 ± 18.5 years) experienced in automated perimetry. One randomly assigned eye was examined at three visits with Program 30-2 of the Humphrey Field Analyzer (HFA). The first visit was a familiarization session. A two-period crossover design with order randomization within visits was used over the second and third visits. SITA Standard, SITA Fast, and HFA 640 Full Threshold were administered during one visit. FASTPAC and HFA 750 Full Threshold were administered during the remaining visit.

RESULTS. Group mean Mean Sensitivity was 0.8 dB higher for SITA Standard than for Full Threshold (P < 0.001) and 1.3 dB higher for SITA Fast than for Full Threshold (P < 0.001). A similar trend was found between SITA and FASTPAC. The group mean Mean Sensitivity for SITA Fast was 0.5 dB higher than for SITA Standard (P < 0.001). The pointwise between-algorithm difference in sensitivity was similar for all algorithms. The pointwise between-algorithm, between-subject variability was lower for SITA. The examination durations for SITA Fast and SITA Standard were half those for FASTPAC and Full Threshold; SITA Fast was 41% that of SITA Standard (P < 0.001).

CONCLUSIONS. SITA produced marginally higher mean mean sensitivity compared with that of existing algorithms and markedly reduced examination duration. The reduced between-subject variability of SITA should result in narrower confidence limits for definition of normality. (Invest Ophthalmol Vis Sci. 1999;40:1152-1161)
For a given subject, the order of algorithms within the session was identical with that administered at the first visit, and the examined with the same three algorithms as at the first visit. Procedure followed an identical protocol. The remaining half visits. At the first visit, threshold was determined for Program UFA. The age distribution was stratified within- and between-decades from the third decade onward (Table 1). The mean age criteria comprised visual acuity of 6/9 or better in each eye, previous ocular surgery or trauma; no history of diabetes mellitus; no history of a congenital color vision defect; no systemic medication known to affect the visual field; no previous ocular surgery or trauma; no history of diabetes mellitus and no family history of glaucoma or diabetes mellitus; and, by definition, normal visual fields in previous examinations.

The study comprised 50 clinically normal subjects (24 men) experienced in Full Threshold automated perimetry with the HFA. The age distribution was stratified within- and between-decades from the third decade onward (Table 1). The mean age was 52.9 ± 18.5 years (range, 23–82 years). The inclusion criteria comprised visual acuity of 6/9 or better in each eye, distance refractive error of 5 D or less mean sphere and less than 2.5 D cylinder; lenticular changes no more than NCIII, NOIII, CI, or PI by LOCS III14; intraocular pressure less than 22 mm Hg in either eye; normal optic nerve head appearance; open angles; no history of a congenital color vision defect; no systemic medication known to affect the visual field; no previous ocular surgery or trauma; no history of diabetes mellitus and no family history of glaucoma or diabetes mellitus; and, by definition, normal visual fields in previous examinations.

The study adopted a two-period crossover design with order randomization within visits. Perimetry in one randomly assigned eye of each subject was undertaken at each of three visits. At the first visit, threshold was determined for Program 50-2 using three algorithms: SITA Standard and SITA Fast, with the HFA 750, and Full Threshold, with the HFA 640. Each algorithm was separated by a rest period of approximately 5 minutes. The order of algorithm was randomized between subjects. The data were then illustrated in terms of the cumulative ranking of the 74 stimulus locations as a function of the extent of the RMS deviation. Identical but separate analyses were undertaken for each of the inferior, superior, nasal, and temporal hemifields and for the central and peripheral annuli.

For the third analysis, the ratio of the SDs of the sensitivity across all subjects at each stimulus location was separately calculated for each of the comparison algorithms in comparison with the gold standard algorithm.

The group mean Mean Sensitivity and the group mean examination duration for each algorithm, together with the group mean Short-term Fluctuation for the FASTPAC and Full Threshold algorithms are shown in Table 2. The Short-term Fluctuation is not calculated by the SITA algorithms. Mean Sensitivity decreased with increase in age for each of the algorithms (P < 0.001). The slope of the function was −0.79 dB per decade for the HFA 750 Full Threshold algorithm, −0.75 dB per decade for the HFA 750 Full Threshold algorithm, −0.75 dB per decade for FASTPAC, −0.72 dB per decade for SITA Standard, and −0.62 dB per decade for SITA Fast. The examination duration increased with increase in age for each of the algorithms (P < 0.001).

**RESULTS**

**Analysis of Variance**

The group mean Mean Sensitivity was similar between the two algorithms (P = 0.214), regardless of age (P = 0.398). The group mean examination duration for the HFA 750 Full Threshold algorithm was 22.2 seconds (2.8%) shorter than that for the
HFA 640 Full Threshold algorithm \((P = 0.031)\), and the difference was independent of age \((P = 0.381)\). The group mean Short-term Fluctuation was similar between the two algorithms \((P = 0.680)\) regardless of age \((P = 0.826)\).

**HFA 750 Full Threshold and FASTPAC Algorithms.** The group mean Mean Sensitivity for the HFA 750 Full Threshold algorithm was similar to that for the FASTPAC algorithm \((P = 0.100)\), and the similarity was independent of age \((P = 0.783)\). Mean Sensitivity varied as a function of the order of algorithm \((P = 0.003)\): It was approximately 0.75 dB higher for whichever algorithm was undertaken first within the visit. The group mean examination duration for the FASTPAC algorithm was 5.25 minutes \((40.6\%)\) shorter than the duration of the HFA 750 Full Threshold algorithm \((P < 0.001)\), and this difference was also independent of age \((P = 0.381)\). The group mean Short-term Fluctuation for the FASTPAC algorithm was 0.4 dB \((35.9\%)\) higher than that for the HFA 750 Full Threshold algorithm \((P < 0.001)\), and this difference was also independent of age \((P = 0.381)\).

**HFA 750 Full Threshold and SITA Standard Algorithms.** The group mean Mean Sensitivity for the SITA Standard algorithm was 0.8 dB higher than that for the HFA 750 Full Threshold algorithm \((P < 0.001)\), and the difference was independent of age \((P = 0.879)\). The group mean examination duration for the SITA Standard algorithm was 6.38 minutes \((49.3\%)\) shorter than that for the HFA 750 Full Threshold algorithm \((P < 0.001)\), and this difference was also independent of age \((P = 0.719)\).

**HFA 750 Full Threshold and SITA Fast Algorithms.** The group mean Mean Sensitivity for the SITA Fast algorithm was 1.30 dB higher than that for the HFA 750 Full Threshold algorithm \((P < 0.001)\), and the difference was independent of age \((P = 0.072)\). The group mean examination duration for the SITA Fast algorithm was 9.10 minutes shorter than that for the HFA 750 Full Threshold algorithm \((P < 0.001)\), and the difference was independent of age \((P = 0.072)\).

**FASTPAC and SITA Standard Algorithms.** The group mean Mean Sensitivity for the SITA Standard algorithm was 0.97 dB higher than that for the FASTPAC algorithm \((P < 0.001)\), regardless of age \((P = 0.703)\). The group mean Mean Sensitivities were higher for both algorithms at the second session \((i.e., the third visit)\) than those at the first session \((P = 0.003)\). The group mean examination duration for the SITA Standard algorithm was 1.13 minutes shorter than that for the FASTPAC algorithm \((P < 0.001)\), and this difference was also independent of age \((P = 0.130)\).

**FASTPAC and SITA Fast Algorithms.** The group mean Mean Sensitivity for the SITA Fast algorithm was 1.47 dB higher than that for the FASTPAC algorithm \((P < 0.001)\). Some evidence was present \((P = 0.057)\) to suggest that the difference in Mean Sensitivity between the algorithms increased with increase in age. The group mean examination duration for the SITA Fast algorithm was 3.85 minutes shorter than that for the FASTPAC algorithm \((P < 0.001)\); however, this difference was independent of age \((P = 0.206)\).

**SITA Standard and SITA Fast Algorithms.** The group mean Mean Sensitivity for SITA Fast was 0.5 dB higher than that for SITA Standard \((P < 0.001)\). The magnitude of the Mean Sensitivity for both SITA algorithms varied within a session as a function of the order of algorithm by an average of approximately 0.3 dB \((P = 0.025)\); the reduction in sensitivity over the session was similar for both algorithms \((P = 0.213)\) and is indicative of a fatigue effect. The difference in sensitivity between algorithms was independent of session \((P = 0.091)\) and of age \((P = 0.239)\). The group mean examination duration for SITA Standard was 2.72 minutes longer than that for SITA Fast \((P = 0.001)\) and was independent of the order of algorithm within a session \((P = 0.767)\) and between the two sessions \((P = 0.843)\). The difference between the two SITA algorithms increased with increase in age \((P = 0.001)\); that is, the saving of time with SITA Fast became greater the older the patient.

**RMS Deviation**

The cumulative ranking of the stimulus locations as a function of the RMS difference between the Full Threshold algorithm and the FASTPAC, SITA Standard, and SITA Fast algorithms are shown in Figure 1 (top) and between the FASTPAC and SITA Standard and SITA Fast algorithms in Figure 1 (middle). The magnitude of the deviation between the Full Threshold algorithm and the SITA Standard algorithm up to the 37th stimulus location \((i.e., the 50th percentile)\) was 2.2 dB. The 10th percentile deviation \((i.e., up to the 8th stimulus location)\) was 1.8 dB, and the 90th percentile \((i.e., up to the 67th stimulus location)\) was 2.9 dB. Of the 74 stimulus locations, 54 showed a difference in the group Mean Sensitivities between the Full Threshold and SITA Standard algorithms of within ±1.0 dB; the remaining 20 locations showed a higher sensitivity for the SITA Standard algorithm. The magnitudes of the RMS differences between the Full Threshold and the SITA Standard algorithm were similar to that between the Full Threshold and FASTPAC algorithm. The corresponding RMS difference between the Full Threshold and the SITA Fast algorithm for the three percentiles were 1.9 dB, 2.4 dB, and 3.1 dB, respectively.

The deviations corresponding to the 50th percentile between the FASTPAC and the SITA Standard and SITA Fast algorithms were 2.4 dB and 2.7 dB, respectively. The 10th

### Table 2. The Group Mean Mean Sensitivity and Group Mean Examination Duration for the SITA Fast, SITA Standard, FASTPAC, HFA 750 Full Threshold, and HFA 640 Full Threshold Algorithms, Together with the Group Mean Short-term Fluctuation for Both Full Threshold Algorithms and for the FASTPAC Algorithm

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Mean Sensitivity (dB)</th>
<th>Duration (min)</th>
<th>Short-term Fluctuation (dB)</th>
<th>Mean Sensitivity (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SITA Fast</strong></td>
<td>29.77 ± 1.59</td>
<td>3.84 ± 0.44</td>
<td>1.58 ± 0.50</td>
<td>28.30 ± 1.86</td>
</tr>
<tr>
<td><strong>SITA Standard</strong></td>
<td>29.27 ± 1.82</td>
<td>6.56 ± 0.69</td>
<td>1.18 ± 0.32</td>
<td>28.47 ± 1.80</td>
</tr>
<tr>
<td><strong>FASTPAC</strong></td>
<td>28.30 ± 1.86</td>
<td>7.69 ± 0.75</td>
<td>1.22 ± 0.53</td>
<td>28.30 ± 1.98</td>
</tr>
<tr>
<td><strong>FT750</strong></td>
<td>12.94 ± 0.94</td>
<td>13.31 ± 1.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FT640</strong></td>
<td>15.10 ± 0.50</td>
<td>16.40 ± 0.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data are means ± SD. FT, Full Threshold.
percentiles were 2.0 dB and 2.1 dB and the 90th percentiles 3.2 dB and 3.1 dB, respectively. The corresponding data between the SITA Standard and SITA Fast algorithms are shown in Figure 1 (bottom); the three percentiles were 1.5 dB, 2.0 dB, and 3.1 dB, respectively.

The 50th percentile of the cumulative ranking of the stimulus locations as a function of the RMS deviation between the various algorithms for the central and peripheral annuli and for the superior, inferior, temporal, and nasal hemifields are shown in Table 3. The 50th percentile RMS deviation was smallest for the central annulus and smallest between the SITA Standard and SITA Fast algorithms. The percentile was greatest for the peripheral annulus and the greatest difference in the percentile was between the FASTPAC and the SITA algorithms.

**SD Ratio**

The SDs of the group mean sensitivity at each of the 74 stimulus locations (i.e., the between-subject normal variability) for the FASTPAC, SITA Standard, and SITA Fast algorithms expressed as a ratio of that of the Full Threshold algorithm at the corresponding location is shown in Figure 2 (left). At the edge locations in the nasal, inferior, and temporal locations, the SDs were larger for the SITA Standard algorithm than that for the Full Threshold algorithm by approximately 18% (Fig. 2; left middle). However, within approximately 21° eccentricity, the SDs for the SITA Standard algorithm were smaller by, on average, 8.5%. The mean of the SITA Standard-Full Threshold ratios for those locations corresponding to the Program 24-2 format, 0.93, was significantly less than unity ($P = 0.002$), whereas that for the Program 30-2 format, 0.99, was not significantly different from unity ($P = 0.70$). The SITA Fast algorithm showed 43 locations with SDs that were smaller by at least 10% compared with the Full Threshold algorithm (Fig. 2; left bottom). Of these 43 locations, 25 showed SDs that were smaller by 20% or more. Within approximately 21° eccentricity, the SDs for the SITA Fast algorithm were, on average, 15.5% lower than those of the corresponding locations for the Full Threshold algorithm. The between-subject variability of the inferior edge locations for the SITA Fast algorithm was generally higher than that of the Full Threshold algorithm. The mean of the SITA Fast-Full Threshold ratios for those locations corresponding to the Program 24-2 format, 0.85, and that for the Program 30-2 format, 0.88, were both significantly less than unity ($P < 0.001$ and $P < 0.001$, respectively).

**Table 3.** The 50th Percentile of the RMS Deviation between Each Pair of Algorithms for the Center and Peripheral Annuli and the Superior, Inferior, Temporal, and Nasal Hemifields

<table>
<thead>
<tr>
<th></th>
<th>Center</th>
<th>Periphery</th>
<th>Superior</th>
<th>Inferior</th>
<th>Temporal</th>
<th>Nasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT/FP</td>
<td>1.94</td>
<td>2.56</td>
<td>2.39</td>
<td>2.08</td>
<td>2.17</td>
<td>2.27</td>
</tr>
<tr>
<td>FT/SS</td>
<td>2.00</td>
<td>2.32</td>
<td>2.32</td>
<td>2.06</td>
<td>2.12</td>
<td>2.19</td>
</tr>
<tr>
<td>FT/FS</td>
<td>2.15</td>
<td>2.51</td>
<td>2.42</td>
<td>2.17</td>
<td>2.36</td>
<td>2.34</td>
</tr>
<tr>
<td>FP/SS</td>
<td>2.27</td>
<td>2.56</td>
<td>2.41</td>
<td>2.43</td>
<td>2.36</td>
<td>2.54</td>
</tr>
<tr>
<td>FP/FS</td>
<td>2.46</td>
<td>2.93</td>
<td>2.68</td>
<td>2.72</td>
<td>2.67</td>
<td>2.78</td>
</tr>
<tr>
<td>SS/FS</td>
<td>1.58</td>
<td>2.33</td>
<td>2.15</td>
<td>1.72</td>
<td>2.01</td>
<td>1.82</td>
</tr>
</tbody>
</table>

Data are in decibels. FT, Full Threshold; FP, FASTPAC; SS, SITA Standard; SF, SITA Fast.
Figure 2. The SD of the group mean sensitivity at each of the 74 stimulus locations (i.e., the between-subject normal variability) for the FASTPAC, SITA Standard, and SITA Fast algorithms, expressed as a ratio of that of the Full Threshold algorithm at the corresponding location (left) and for the SITA Standard and SITA Fast algorithms expressed as a ratio of that of the FASTPAC algorithm (right). FT, Full Threshold; FP, FASTPAC; SS, SITA Standard; and SF, SITA Fast.
The HFA 640 was used to determine the validity of the Full Threshold algorithm with the HFA 750. The two instruments, which are independent in terms of software, yielded similar group mean Mean Sensitivities. The finding of similar Mean Sensitivities and of similar Short-term Fluctuations are compatible with the results of Johnson et al.\textsuperscript{15} who found a similarity in the Mean Deviation, the Short-term Fluctuation and the Corrected Pattern Standard Deviation between the two instruments in ocular hypertension, and in early and moderate glaucoma. Johnson et al.\textsuperscript{15} also found similar local mean sensitivities as a function of eccentricity and of quadrant but did not analyze the data in terms of each individual stimulus location. In the present study, the 10th, 50th, and 90th percentiles for the RMS deviation between the Full Threshold algorithm of the two instruments were 1.7 dB, 2.2 dB, and 3.1 dB, respectively. Such differences are minimal when placed in the context of the 2 dB final step size of the Full Threshold algorithm. The 22 second reduction in examination time of the HFA 750 Full Threshold algorithm compared with that of the HFA 640 is likely to have arisen from the aspheric shape and smaller size of the perimeter bowl of the HFA 750, the faster stepper motor used for the stimulus presentation, and the faster speed of the microprocessor.

The validity of the sample as representative of the normal population was confirmed by the differences in the examination duration and in the Short-term Fluctuation between the HFA 750 Full Threshold and the FASTPAC algorithms. The approximate 40% reduction in the examination duration and the approximate 34% increase in the Short-term Fluctuation for FASTPAC was comparable with that reported previously for the normal visual field.\textsuperscript{7} The slope of the normal age-decline in Mean Sensitivity for the HFA 640 and HFA 750 Full Threshold algorithms was also compatible with that reported previously.\textsuperscript{16}

The Group mean Mean Sensitivity of SITA Standard was 0.8 dB higher than that of the Full Threshold algorithm; however, the two means can be considered essentially to be clinically equivalent. The pointwise RMS deviations between the Full Threshold algorithm and the SITA Standard were also clinically equivalent, although the upper tail of the distribution was longer than that between the Full Threshold and FASTPAC algorithms. The group mean Mean Sensitivity for the SITA Fast algorithm was 1.3 dB higher than that of the Full Threshold algorithm. The pointwise RMS deviations reflected this tendency across the entire distribution of stimulus locations (the corresponding curve in Fig. 1 [top] shifts to the right relative to the other two curves). The deviations also had a longer upper tail than that between the Full Threshold and FASTPAC algorithms.

The Full Threshold strategy, in the case of central field examination, initially determines the threshold twice at each of four seed locations situated along the oblique meridians at approximately 13° eccentricity in each quadrant. The starting luminance at these initial seed locations is 25 dB; the final 2 dB crossing of threshold occurs in either an ascending or descending direction, and the threshold is designated as the last-seen stimulus luminance. Threshold is then determined at the immediate adjacent locations. The initial starting luminance at these secondary locations is 2 dB brighter than the expected value derived from knowledge of the sensitivity at the primary location and of the slope of the hill of vision. With FASTPAC, the procedure for obtaining the threshold at the four primary locations and for calculation of the expected value at the secondary locations is identical with that of the Full Threshold algorithm. However, the initial starting luminance for the sec-

**DISCUSSION**

The HFA 640 was used to determine the validity of the Full Threshold algorithm with the HFA 750. The two instruments, which are independent in terms of software, yielded similar group mean Mean Sensitivities. The finding of similar Mean Sensitivities and of similar Short-term Fluctuations are compatible with the results of Johnson et al.\textsuperscript{15} who found a similarity in the Mean Deviation, the Short-term Fluctuation and the Corrected Pattern Standard Deviation between the two instruments in ocular hypertension, and in early and moderate glaucoma. Johnson et al.\textsuperscript{15} also found similar local mean sensitivities as a function of eccentricity and of quadrant but did not analyze the data in terms of each individual stimulus location. In the present study, the 10th, 50th, and 90th percentiles for the RMS deviation between the Full Threshold algorithm of the two instruments were 1.7 dB, 2.2 dB, and 3.1 dB, respectively. Such differences are minimal when placed in the context of the 2 dB final step size of the Full Threshold algorithm. The 22 second reduction in examination time of the HFA 750 Full Threshold algorithm compared with that of the HFA 640 is likely to have arisen from the aspheric shape and smaller size of the perimeter bowl of the HFA 750, the faster stepper motor used for the stimulus presentation, and the faster speed of the microprocessor.

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ondary locations is 2 dB dimmer than the expected threshold when the expected value is an odd number and 1 dB brighter when the expected value is an even number.

With the SITA algorithms, the threshold estimate and the measurement error associated with the threshold estimate are continually calculated throughout the examination. Both SITA algorithms compare each response of the patient with previously determined models of the normal and glaucomatous visual fields. The two models are based on a knowledge of the age-corrected normal threshold values, the between-subject variability in the estimation of threshold, the variation in the shape of the frequency-of-seeing curve between stimulus locations, and the interdependence of threshold values at adjacent visual field locations. At each stimulus location, two likelihood functions are calculated before the examination, one for normal responses and one for glaucomatous responses. Both likelihood functions are adjusted after the positive or negative response to each stimulus, and the shape of the function changes with increase in the number of responses. The peak of the function at any given moment represents the most likely threshold value, and the width is an indication of the accuracy of the threshold estimate. The SITA Standard algorithm uses a 4-2 dB step size and the SITA FAST algorithm a 4 dB step size. The thresholding procedure at any given location is terminated at a predetermined level of accuracy that is specified by the error-related factor.17 At the end of the examination, the threshold values are recomputed using all the information gained during the examination. Threshold is designated as the stimulus luminance with a 50% probability of seeing. The examination duration is further shortened by the elimination of false-positive catch trials,18 by the reduction in the number of catch trials required for false-negative estimation, and by the shorter interstimulus interval made possible by an improved determination of the patient's reaction time and the faster stepper motors of the HFA 700 series.12

An intrinsic difference would thus be expected in the magnitude of the derived sensitivity values between the Full Threshold, FASTPAC, and SITA algorithms. The theoretical difference in sensitivity between the Full Threshold and FASTPAC algorithms is 0.5 dB, between Full Threshold and SITA Standard is 1.0 dB, and between FASTPAC and SITA Standard is 1.5 dB. However, the sensitivity values derived by the SITA algorithms are corrected for these expected differences in threshold.

The measured values were 1 dB lower than those reported by Bengtsson et al.,13 namely, 1.9 dB between Full Threshold and SITA Standard and 2.0 dB between FASTPAC and SITA Standard. The difference between the sensitivities estimated by the Full Threshold and FASTPAC algorithms and those estimated by the SITA algorithms as a function of stimulus location (i.e., the between-algorithm differences in the respective hills of vision) are shown in Figures 4 and 5. The mean of the difference at each stimulus location between each algorithm confirmed the trend of the difference in the respective mean sensitivities; however the SDs of the pointwise differences were almost all larger than the corresponding means, indicating that the associated variability was greater than any differences between the hills of vision.

The measured and predicted disparities between the sensitivities for the SITA algorithms and those of the Full Threshold and FASTPAC algorithms could theoretically be decreased by reducing the magnitude of the designated error-related factor. However, such an alteration would be at the expense of an increase in the examination duration. It would be theoretically possible to create a whole family of SITA algorithms by alterations in the error-related factor.12

Both SITA algorithms use prior knowledge of the shape of the frequency-of-seeing curve. The accuracy and precision of a staircase threshold algorithm is dependent on the starting level of the staircase, the size of the staircase steps, the number of staircase reversals, and the stimulus size.2-5 The original 4-2 dB staircase was developed on the assumption that the shape of the frequency-of-seeing curve was independent of stimulus location. However, the shape of the curve varies with threshold level and, as a consequence, covaries with stimulus eccentricity and with defect depth.23-25 It is different between normal subjects and glaucoma patients for a given threshold level and is also different among glaucoma patients.23-25 Stimulus locations showing normal sensitivity in glaucoma can also show considerable variation in the shape of the curve.23-24 The characteristics of the frequency-of-seeing curves used by the SITA algorithms have not been described. Until such information becomes available, the manner in which the prior knowledge of the curves contributes to the SITA algorithms remains unknown.

Initial step sizes, which vary in magnitude as a function of eccentricity and of defect depth, are used in the Dynamic Strategy20 as a means of reducing examination duration without loss of efficiency. The Dynamic Strategy reduces the variance associated with the measurement of normal sensitivity compared with the 4-2 dB strategy; however, the variance is greater at locations showing relative loss.20 The precision of the models incorporated in the SITA algorithms evidently renders the use of dynamic step sizes unnecessary, even for the measurement of normal sensitivity.

Fundamental to the delineation of visual field loss is the establishment of confidence intervals for normality at each stimulus location. Such intervals, based either on Gaussian or empiric distributions, are used to identify abnormalities in the height and the shape of the visual field. Fifty-eight of the 74 stimulus locations showed a Gaussian distribution of sensitivity for the HFA 750 Full Threshold algorithm, 57 locations for the SITA Standard, and 58 locations for the SITA Fast algorithm. Of the 58 locations for the Full Threshold algorithm, 57 were common to the SITA Standard and 45 to the SITA Fast algorithm. The shape of the distribution of sensitivity for the Full Threshold algorithm is equivocal; it has been previously described as either non-Gaussian16,26 or predominantly Gaussian.27

It is clear from the data in Figure 2 that the SDs for both SITA algorithms are smaller than those of the Full Threshold and FASTPAC algorithms, within the central regions of the field, and that the SDs for SITA Fast are generally smaller than those for SITA Standard (Fig. 3). The SDs for SITA would also seem to show age and eccentricity dependencies. The SITA Standard SDs of the 21 subjects aged less than 50 years were virtually identical with those of 21 randomly selected subjects aged more than 50 years within the central annulus. However, the SDs for the peripheral annulus were approximately 14% greater in the older group. The SITA Fast SDs were approximately 13% greater in the older age group in both annuli. It can be inferred from the SDs that the SITA algorithms possess narrower confidence limits for normality within 21° eccentricity than do the Full Threshold and FASTPAC algorithms. As a
Figure 4. The mean and one SD of the within-subject differences in sensitivity at each of the 74 stimulus locations between the Full Threshold algorithm and the FASTPAC, SITA Standard, and SITA Fast algorithms (left), and between the FASTPAC and SITA Standard and SITA Fast algorithms (right). FT, Full Threshold; FP, FASTPAC; SS, SITA Standard; SF, SITA Fast.

The mean and one SD of the within-subject differences in sensitivity at each of the 74 stimulus locations between the Full Threshold algorithm and the FASTPAC, SITA Standard, and SITA Fast algorithms (left), and between the FASTPAC and SITA Standard and SITA Fast algorithms (right). FT, Full Threshold; FP, FASTPAC; SS, SITA Standard; SF, SITA Fast.

consequence, visual field abnormality is likely to be statistically detected at an earlier stage than with the Full Threshold and FASTPAC algorithms.

The reason for the reduced SDs of SITA is not clear. An attractive hypothesis would be a reduction in the magnitude of, and the between-individual variation in, the fatigue effect
Threshold and FASTPAC algorithms. has potential profound

tively permits either the same patients to undergo perimetry
approximately twice as frequently or the throughput of pa-
tients for visual field examination to double approximately per
ment of glaucoma. The reduced examination duration effec-
t have yet been undertaken. Alternatively, the magnitude of
the designated error-related factor together with the model
for the normal hill of vision and the postprocessing may inad-
vertently and artificially reduce or “smooth” the appearance
of the field, thereby reducing the between-subject variation in
normal sensitivity.

The reason for the greater between-subject variation of the
SITA algorithms at the edge locations compared with the
Full Threshold algorithm is unclear but may reflect the reduced
efficacy of the SITA algorithm at these locations. However, the
use of Program 24-2, which omits all the edge locations of
Program 30-2 except those in the nasal field either side of the
horizontal midline, would minimize this limitation. The false-
positive rate of the SITA algorithms remains unknown.

The gray-scale representation of sensitivity for the Full
Threshold and FASTPAC algorithms is not age-related and does
not take into account the increase in variability with increase in
stimulus eccentricity. Consequently, a given level of gray can
be associated with differing total and pattern deviation proba-
bility symbols within-and between-locations for a given patient
and also between patients. It can be speculated that the nar-
rower confidence limits for the SITA algorithms correspond
to lighter levels of gray than those for the Full Threshold algo-
rithm, particularly for the proportionately larger deviations from
normality. It is also conceivable that the width of the confidence
limits for SITA may be such that multiple changes in probability level occur within a given level of gray.

The approximate halving of the examination duration for
SITA Standard and SITA Fast, together with clinically similar
threshold estimates in the normal eye compared with the Full
Threshold and FASTPAC algorithms, has potential profound
implications for the role of perimetry in the clinical manage-
ment of glaucoma. The reduced examination duration effec-
tively permits either the same patients to undergo perimetry
approximately twice as frequently or the throughput of pa-
tients for visual field examination to double approximately per
unit time. The possible reduction of the fatigue effect with
SITA initially has potential ramifications for the examination of

arising from the shorter examination duration of SITA. How-
ever, no studies on the algorithm-specific nature of the fatigue
effect have yet been undertaken. Alternatively, the magnitude of
the designated error-related factor together with the model
for the normal hill of vision and the postprocessing may inad-
vertently and artificially reduce or “smooth” the appearance
of the field, thereby reducing the between-subject variation in
normal sensitivity.

The reason for the greater between-subject variation of the
SITA algorithms at the edge locations compared with the
Full Threshold algorithm is unclear but may reflect the reduced
efficacy of the SITA algorithm at these locations. However, the
use of Program 24-2, which omits all the edge locations of
Program 30-2 except those in the nasal field either side of the
horizontal midline, would minimize this limitation. The false-
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the visual field in glaucoma. The fatigue effect is most apparent
at those locations that show relative loss, varies between indi-
viduals in magnitude, and leads to an overestimation of the
defect depth. It is therefore possible that some glaucoma-
tous fields will seem less severe when examined with either of
the SITA algorithms compared with the findings in the imme-
diate previous examination undertaken with the Full Threshold
algorithm. The hypothesis, together with the fact that the likely
narrower confidence limits associated with the SITA algo-
rithms may mitigate against such an eventuality, should be
investigated.

The profound reduction in the examination duration of the
two SITA algorithms without loss of accuracy in the normal
eye compared with the Full Threshold algorithm, together with
the reduced between-subject variability and therefore likely
narrower confidence limits for normality, seemingly heralds a
new dawn for automated perimetry.

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