Visual Field Characteristics of Normal Subjects using the Peripheral 60-4 Test for Stimulus Sizes III, V, and VI

Michael Wall (michael-wall@uiowa.edu)
University of Iowa https://orcid.org/0000-0002-9802-4806
Iván Marín-Franch
Computational Optometry
Jordan Haas
Des Moines University
Chris A Johnson
University of Iowa

Research Article

Keywords: Perimetry, Visual Field, Vision Testing

Posted Date: December 19th, 2018

DOI: https://doi.org/10.21203/rs.2.134/v1

Abstract

Purpose: To investigate whether the visual field characteristics, which are well known for Goldmann stimulus size III in the central 30°, hold true for the 30°–60° visual field for stimulus sizes III, V and VI.

Methods: One eye of 60 healthy participants ages 19–78 years, mean age 49.5 ± 18.0 were tested with stimulus sizes III, V and VI on two separate visits with the Humphrey 60–4 program. Pointwise between-subject variability of the average visual field of the two visits was estimated after correcting for age effects as the standard deviation across subjects. Within-subject variability was estimated as the standard deviation of the differences between visits.

Results: For the 60–4 testing, the age-corrected mean sensitivity over all test locations was smallest for size III at 22 dB. It was 7 dB greater for size V and 9 dB greater for size VI. Sensitivities decreased by about 0.38, 0.34 and 0.31 dB / degree eccentricity with sizes III, V, and VI, respectively. The differences in mean sensitivity and in eccentricity effects were statistically significant among sizes ($p < 0.001$). Pointwise between- and within-subject variability was greatest in the nasal and superior visual field and inversely proportional to stimulus size.

Conclusions: Visual field sensitivity was lower for smaller stimulus sizes and decreased with eccentricity and age. The between- and within-subject variability decreased with increasing stimulus size. These findings provide a basis for quantitative assessment of 60-4 visual field properties in patients with ocular and neurologic disorders.

Keywords: Perimetry, Visual Field, Vision Testing

Introduction

Von Graefe introduced perimetry into clinical medicine in 1856.[1] Using a chalk board and a piece of chalk, he tested the central visual field (area inside 30° eccentricity). To test the far periphery, outside 30°, Aubert instituted the arc perimeter.[2] Since that time, emphasis has shifted from the central visual field, for example Bjerrum's work,[3] to the periphery with the introduction of the Goldmann perimeter.[4] With the advent of automated perimetry, initially both the central and peripheral fields were tested. However, use of the relatively small Goldmann size III stimulus (0.43°diameter) in the periphery was not only a difficult task but the testing time was more than doubled to obtain both the central and peripheral field data in a subject. Since it appeared that most of the useful information was in the central field, little investigation of static automated perimetry has been performed for testing outside 30° eccentricity.

Several reports address normative limits for the far periphery, but the methods are either not well described or the data presented is difficult to translate into a form useful for clinical practice. Brenton and Phelps[5] obtained thresholds for both the central 30° and the 30–60° field using the Goldmann size III stimulus with a full threshold i.e., staircase strategy, in 102 healthy observers that were naïve perimetry subjects. They found a gradual uniform decline in sensitivity with age throughout the visual field.

Between-subject variability increased with both eccentricity and age. They also noted a greater short-term fluctuation in the area outside 30°. Their results for the central 30° are similar to those of Heijl et al.[6]

Fechtner and coworkers tested the visual field from 30–60° with a Humphrey Field Analyzer 60–4 program apparently with the Goldmann size III stimulus (not specified).[7;8] This test estimates sensitivities for 60 test locations with a grid spacing of 12°. They tested 94 subjects taking Vigabatrin twice at baseline and periodically over 12 weeks of treatment; a final test was given one month after cessation of treatment. They reported high retest variability and defects in the superior and nasal outer ring zone that did not progress during the study; some of these defects were transient and attributed to eyelid and head turn artifacts. They did not find any significant deterioration from baseline in visual function except for a group mean change in the sensitivity of the middle ring. This research group conducted a followup study of threshold sensitivity for the 60–4 test in 33 healthy participants.[9] The mean test time was 6.24 minutes so it is not clear that full threshold testing was performed because it routinely takes about twice as long as the test time that they reported. They again noted high retest variability in the outer ring of test locations superiorly and nasally.

Standard current perimetry practice for glaucoma testing involves estimation of sensitivities for locations within the central 24 or 30 degrees of the visual field (24–2 and 30–2 test patterns). While it appears from many studies of kinetic perimetry that testing of the central visual field is adequate, there are no recent studies of static perimetry in glaucoma or other optic neuropathies outside of 30°. Some neuro-ophthalmologists and retina specialists still use Goldmann kinetic perimetry because there is important shape information revealed by testing outside 30° that can be useful in diagnosing and monitoring various toxic and degenerative retinal disorders and glaucoma[7;10-12] with fewer centers now using Goldmann kinetic perimetry, many clinicians no longer have useful information about the visual field beyond 30°. Recent studies indicate that testing with Goldmann sizes V (1.72° of diameter) and VI (3.44°) may be useful for following visual loss in glaucoma as they have lower retest variability and a greater dynamic range.[13;14] These larger stimuli are easier for subjects to attend to in the far periphery and appear to be excellent candidates for testing of the far peripheral field.

In summary, the data regarding the characteristics of the normal visual field outside 30° (normative values, within and between subject variability, eccentricity and age effects) are poorly described in the literature for Goldmann stimulus sizes III, V and VI. Our goal is to investigate whether these visual field characteristics, which are well known for Goldmann stimulus size III in the central 30°, hold true for the 30–60° visual field for these three stimulus sizes. This knowledge will allow informed interpretation of 60–4 visual field testing currently not available.

Methods

Subjects: The visual testing protocol was approved by the University of Iowa Institutional Review Board. The tenets of the Declaration of Helsinki were followed. Sixty ocular healthy subjects were tested at baseline and again at a separate sitting within 1–4 weeks. All subjects gave written informed consent to

participate in the study. The subjects answered advertisements inviting them to participate in research and were paid in agreement with the Institutional Review Board. All participants signed a written informed consent approved by the Institutional Review Board. The subjects had an average age of 49.5 ± 18.0 and a range of 19–78. There were approximately 10 subjects per decade. Forty-three of the volunteers were women and 17 were men.

Participants were considered normal if they had (1) no history of eye disease except refractive error; (2) no more optical correction than five diopters of sphere or three diopters of cylinder distance correction, (3) no history of diabetes mellitus or systemic arterial hypertension, and (4) a normal ophthalmologic examination including 20/25 or better best-corrected Snellen visual acuity. The subjects either had undergone a complete eye exam within 12 months prior to this study or were examined by an ophthalmologist on the day of testing to ensure normal ocular health.

Visual Testing: All subjects underwent testing of the 30–60° area of the visual field with the Humphrey Field Analyzer 60–4 test using full threshold testing algorithm for Goldmann sizes III, V and VI, corresponding to diameters of 0.43°, 1.72° and 3.44°, respectively. In addition, participants had testing of the central 21° with size III stimuli using the SITA standard 24–2 algorithm with the four tests performed in random order. The manufacturer's recommendations were followed, and a corrective lens was used when necessary for the SITA Standard central visual field testing. Care was taken to prevent lens rim artifacts. The subjects had testing in one eye, chosen at random, and the same eye was used for all tests. All visual field examinations met the following reliability criteria: fixation losses less than 20% or normal gaze tracking, false positive rate < 10% and false negative rate < 33%. Except for between- and within-subject variability analyses, results of the second test were used for all analyses to minimize the possible influence of practice effects.

The focus of our study was the 60-4 visual field. Since taking three 60-4 tests was so time consuming we used SITA 24-2 for the central visual field realizing the sensitivities were not directly comparable. In addition, we separately compares size III full threshold testing with size V full threshold testing by testing 5 normal subjects once a week for five weeks across decades with size III full threshold and size III SITA and compared the retest results. Our data confirm a 1-2 dB increase in sensitivity for SITA testing but minimal if any differences in repeatability (data available upon request).

Statistical Analysis: We examined the effect of age on sensitivity with simple linear regression in each location using the second test for each subject. After correcting for the pointwise age-effect, we examined the effect of eccentricity on sensitivity. Although the data is not strictly linear at the far edges of the measured visual field, we used simple linear regression as an approximation as some of the non-linearity is likely due to edge artifact. The paired Wilcoxon signed-rank test was used to see if there were differences in mean normal sensitivity, and age and eccentricity effects between stimulus Goldmann sizes III and V, sizes III and VI, and sizes V and VI.

For each stimulus size, we estimated the between- and within-subject variability after correcting for age effect at each location. For the between-subject variability, we averaged the sensitivities of the two tests

taken by each subject and then calculated the 60 standard deviations over all subjects. For the within-subject variability, we obtained the differences in sensitivity between tests and then calculated the 60 standard deviations over all subjects.

All statistical analyses were performed in R.[15] The significance level for all 12 significance tests were set at 0.05 / 15 = 0.003 after applying Bonferroni correction for multiple comparisons.

Results

Figures 1 (left) and 2b-d show the age-corrected pointwise mean normal sensitivities standardized for a 45-year-old person at the test locations in Fig 2a. There was a gradual decrease in sensitivity (Fig 1a left) with eccentricity for the Goldmann size III results for the 60° surrounding fixation except for some test locations in the far peripheral edge (in red in Fig 2) and locations known to be susceptible to lid artifacts (in yellow), for which sensitivity dropped substantially. Figures 1b and c, and 2 c and d show data for the 30° to 60° test locations of the 60–4 test. Although similar findings were observed for the larger stimulus sizes, there were fewer edge locations for which sensitivity dropped substantially. The right side of Figure 1 shows the point-wise age-effect slopes (in dB per decade) for the three stimulus sizes. Note the change in slope is greatest for Goldmann stimulus size III and least for size VI.

Mean sensitivities were smallest for Goldmann size III at 22.2 dB. They were, on average, 7.1 dB and 9,2 dB greater for size V and VI, respectively. The average age effect for Goldmann sizes III, V, and VI with the 60–4 test was −0.97, −0. 76, and −0. 56 dB per decade, respectively. After correcting for age, the sensitivities decreased by about −0.37, −0.34, and −0.31 dB per degree of visual angle for Goldmann sizes III, V, and VI, respectively. All differences between Goldmann size III and size V, size III and size VI, and size V and size VI were all significantly different from zero. The average age effect for SITA Standard size III of the 24–2 test was −0.59 dB / decade.

Figure 3 shows the pointwise within- (left) and between-subject (right) standard deviations after age correction for the Goldmann size III with the 30–2 SITA standard and the 60–4 full-threshold tests (top), and for Goldmann sizes V (middle) and VI (bottom) for the 60–4 full-threshold test. The mean estimated within-subject standard deviations were 3.1, 2.8, and 2.4 dB, for Goldmann sizes III, V, and VI, respectively. Differences between Goldmann size III and size V, size III and size VI, and size V and size VI were all significantly different from zero. The mean estimated between-subject deviations were similar at 3.3, 2.8, and 2.5 dB. Differences between Goldmann size III and size V, size III and size VI were significantly different from zero, but the difference between size V and size VI was not after Bonferroni correction (p = 0.004). It is clear that the outer superior and nasal test locations have greater within- and between-subject variability than test locations elsewhere in the visual field for all stimulus sizes.

The mean increase in sensitivity on retest across test locations (learning effect) was less than 0.1 dB for all stimulus sizes. When the most eccentric zone was analyzed, there was less than 0.2 dB improvement.

Figure 4 shows the conditional test–retest distribution and limits established from the empiric 5th and 95th percentiles. For all three stimulus sizes, retest variability is small above about 25 dB and worsens below that level. The highest sensitivities for size III are in the low 30 dB, for size V in the mid 30 dB, and for size VI in the high 30 dB.

A typical example of 60–4 visual field examinations from a subject is shown in Figure 5. Notice the common inferior nasal depression or “dent” that does not respect the horizontal meridian, most prominent with the size III stimulus. We had two examples of marked nasal contractions, one of which is shown in Figure 6. Both subjects with these contractions had deep set orbits with prominent brows.

Average of examination times ± standard deviation for full-threshold testing of the 60–4 tests were 12.3 ± 1.1 minutes for Goldmann size III, 11.7 ± 1.0 for size V and 11.4 ± 0.9 for size VI testing. SITA Standard testing of the central 24° took 4.7 ± 0.5 minutes per test. The average false positive rate for the 60–4 size III testing was 1.6 ± 3.3 %, size V 1.4 ± 3.3 % and for size VI, 1.2 ± 3.1 %; the false positive rate for SITA Standard was 1.2 ± 1.6 %. The corresponding false negative rates were 3.2 ± 6.2 %, 2.4 ± 5.2 % and 1.2 ± 3.3 %; the rate for SITA Standard testing was 0.7 ± 1.9 %.

Discussion

Why should a 60–4 test be used? Although the 24–2 grid is the most commonly used one in clinical practice, measuring the far peripheral visual field is important for some retinal degenerations[11;16] and vigabatrin toxicity.[8] Also, this region is largely unexplored with conventional static automated perimetry in glaucoma and other optic neuropathies. Of note, Caproli and Spaeth[12] found 11% of eyes had peripheral nasal defects when there was no loss centrally with static automated perimetry. The inferior temporal periphery also appears to be fertile territory for testing as Hood and coworkers note a high incidence of superior nasal retinal nerve fiber layer defects that correspond to the inferior temporal far peripheral visual field.[17] Therefore, testing of the far peripheral visual field can provide useful clinical information.

We found variability, especially with larger test stimuli, in many areas of the periphery is no larger than in the central visual field. Using these larger stimuli, the far periphery can be accurately mapped except for superior and nasal edge locations due to their high within- and between subject variability (Figure 7).

We found the rate of decrease in sensitivity with eccentricity for size III in the central 30° continues into the periphery until some of the far superior and nasal test locations on the edges of the test grid are reached. At those locations, average sensitivity falls abruptly (see Figures 1 and 2). The decrease in average sensitivity in the superior edge is likely due to eyelid artifacts; the decrease in the nasal edge is likely due to subjects with deep-set orbits. These eyelid-related artifacts and deep-set orbits also led to much greater within- and between-subject standard deviations (Figure 3). Figure 7 shows histograms for age-corrected differences from mean normal for all subjects using the Goldmann size III stimulus at a location for the 24–2 test and three locations for the 60–4 test, two of which are at the edge. Importantly, the distribution for the 60–4 test location in the inferior temporal visual field is not much wider than the

24–2 test location. But for the edge locations, the distributions are much wider. In fact, the percentile 5 goes from about −2 dB to about −13 dB for the edge locations. Subjects would need to show a loss of more than 13 dB from age-corrected mean normal values for these locations to be flagged as suspect in a probability map. This example illustrates how insensitive these locations are to flagging of a pointwise defect. The results are similar to the 60–4 results of Berezina using only size III (n = 33).[9] We suggest superior and nasal edge locations at these eccentricities be eliminated from this and other similar test grids.

We found acceptable retest variability (Figure 3, left and Figure 4) for all three stimulus sizes for values above about 25 dB. After adjusting for higher sensitivities with larger stimulus sizes there is little difference in the low variability ranges for the three stimulus sizes except that size VI has more useful dynamic range based on low variability (22 – 32 dB vs 22 – 40 dB. This is similar to results from the central 21° in glaucoma subjects that show a larger useful dynamic range for larger stimulus sizes.[18-20]

Our results show a point-wise effect of age (in dB per decade – Figure 1 right). This effect increases with increasing eccentricity. The effect for the central 21° of -0.94 dB per decade is similar to that reported by Spry and Johnson[21] with full threshold testing -0.64 dB/decade and Bengtsson and Heijl[22] with SITA Standard of -0.64 dB/decade). Note the change in slope is greatest for Goldmann stimulus size III and least for size VI. A similar finding of a decreased slope with aging has been reported by Phu and coworkers.[23] This accelerated effect of aging in the far periphery compared with the effect in the central visual field has also been noted with size III testing by Rutkowski and May.[24] Our new finding is that this effect is less apparent with the size VI stimulus.

We found little learning effect with repeat testing in this data set. The mean increase in sensitivity on retest across test locations was less than 0.1 dB for all stimulus sizes. And the effect for the most eccentric zone was less than 0.2 dB improvement. This near lack of learning effect is probably related to subjects taking four tests in random order and transfer of training and learning taking place.

Nasal depressions that do not respect the horizontal meridian are common. A typical visual field examination example is shown in Figure 5. Notice inferior nasal depression or “dent” that does not respect the horizontal meridian, most prominent with the Goldmann size III stimulus. Also, we had two examples of very large nasal contractions, one of which is shown in Figure 6. Both subjects with these contractions had deep-set orbits with prominent brows. Therefore, care should be taken when interpreting superior and nasal contractions in subjects with this type of orbital anatomy.

The standard printout used for the 60–4 results with the HFA, is not based on a database of normals and therefore, the HFA does not have a statistical package with probability plots for these tests. Therefore, clinicians have little guidance for interpreting 60–4 results. Phu and coworkers[25] have estimated that for full threshold tests, as few as 60 healthy observers’ results might be used to estimate cutoff levels for pointwise empirical probability plots. If this suggestion is correct, our data, might be used to generate

these plots. However, we caution that this number may be inadequate and suggest a larger sample be used.

Conclusions

We found variability, especially with larger test stimuli, to be in a very acceptable range except for the far superior and nasal test locations. This variability in most areas of the periphery is essentially no larger than in the central visual field. The effects of age are more pronounced in peripheral locations and the effects of eccentricity on age-corrected sensitivity for locations within 30–60° fall on a continuum from the effects for locations in the central 30° using Goldmann size III. Peripheral 60-4 testing, especially with larger stimulus sizes may be a useful adjunct for clinical practice as long as the far superior and nasal test locations are disregarded when interpreting these tests for evidence of visual loss.

Abbreviations

Abbreviations: dB – decibel, SITA – Swedish Interactive Threshold Algorithm

Declarations

Ethics approval and consent to participate: University of Iowa IRB approval, signed informed consent was given by all subjects

Consent for publication: All authors consent
Availability of data: upon request
Material Competing Interests: None

Funding: VA Merit Review Grant # I01 RX-001821-01A1, and by an unrestricted grant to the Department of Ophthalmology from Research to Prevent Blindness, New York, N.Y., USA. These funding entities had no role in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript

Authors' contributions: MW – designed experiment, supervised experiment, wrote and revised manuscript; IMF – Analyzed data, revised manuscript; JSH – conducted experiment, revised manuscript; CAJ – revised manuscript

Acknowledgements: none

References

1. von Graefe A. Ueber die Untersuchung des Gesichtsfeldes bei amblyopischen Affectionen. *Von Graefe's Arch Ophthalmol* 1856;2:258-98.

2. Aubert H. Uber die Grenzen der Farbenwahrnehung auf den seitlichen Teilen der Retina. *Von Graefe's Arch Ophthalmol* 1857;3:38-67.
3. Bjerrum JP. Om en tilfoelse til saedvanllige synsfeltundersogelse samt om synfeltet ved glaukom. *Nord Othth Tidsskr Kkjobenh* 1889;2:144-85.
4. Goldmann H. Ein selbstregistrierendes Projektion skulperimeter. *Ophthalmologica* 1945;109:71-9.
5. Brenton RS, Phelps CD. The normal visual field on the Humphrey field analyzer. *Ophthalmologica.* 1986;193:56-74.
6. Heijl A, Lindgren G, Olsson J. Normal variability of static perimetric threshold values across the central visual field. *Arch Ophthalmol* 1987;105:1544-9.
7. Berezina TL, Khouri AS, Winship MD, Fechtner RD. Visual field and ocular safety during short-term vigabatrin treatment in cocaine abusers. *Am.J Ophthalmol* 2012;154:326-32.
8. Fechtner RD, Khouri AS, Figueroa E, Ramirez M, Federico M, Dewey SL et al. Short-term treatment of cocaine and/or methamphetamine abuse with vigabatrin: ocular safety pilot results. *Arch.Ophthalmol* 2006;124:1257-62.
9. Berezina TL, Khouri AS, Kolomeyer AM, Clancy PS, Fechtner RD. Peripheral visual field thresholds using Humphrey Field Analyzer program 60-4 in normal eyes. *Eur.J Ophthalmol* 2011;21:415-21.
10. Frisen L. Vigabatrin-associated loss of vision: rarebit perimetry illuminates the dose-damage relationship. *Acta Ophthalmol Scand.* 2004;82:54-8.
11. Nowomiejska K, Brzozowska A, Koss MJ, Weleber RG, Schiefer U, Rejdak K et al. Quantification of the Visual Field Loss in Retinitis Pigmentosa Using Semi-Automated Kinetic Perimetry. *Curr.Eye Res.* 2016;41:993-8.
12. Caprioli J, Spaeth GL. Static threshold examination of the peripheral nasal visual field in glaucoma. *Arch Ophthalmol* 1985;103:1150-4.
13. Wall M, Woodward KR, Doyle CK, Artes PH. Repeatability of automated perimetry: a comparison between standard automated perimetry with stimulus size III and V, matrix, and motion perimetry. *Invest Ophthalmol.Vis.Sci.* 2009;50:974-9.
14. Wall M, Woodward KR, Doyle CK, Zamba G. The effective dynamic ranges of standard automated perimetry sizes III and V and motion and matrix perimetry. *Arch Ophthalmol* 2010;128:570-6.
15. R Core Team. A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/. 2017.
16. Berson EL, Rosner B, Sandberg MA, Weigel-DiFranco C, Brockhurst RJ, Hayes KC et al. Clinical trial of lutein in patients with retinitis pigmentosa receiving vitamin A. *Arch Ophthalmol.* 2010;128:403-11.
17. Hood DC, Wang DL, Raza AS, De Moraes CG, Liebmann JM, Ritch R. The locations of circumpapillary glaucomatous defects seen on frequency-domain OCT scans. *Invest Ophthalmol.Vis.Sci.* 2013;54:7338-43.
18. Wall M, Zamba GKD, Artes PH. The Effective Dynamic Ranges for Glaucomatous Visual Field Progression With Standard Automated Perimetry and Stimulus Sizes III and V. *Invest Ophthalmol Vis*

Sci. 2018;59:439-45.

19. Gardiner SK, Swanson WH, Demirel S. The Effect of Limiting the Range of Perimetric Sensitivities on Pointwise Assessment of Visual Field Progression in Glaucoma. *Invest Ophthalmol.Vis.Sci.* 2016;57:288-94.
20. Wall M, Woodward KR, Doyle CK, Zamba G. The effective dynamic ranges of standard automated perimetry sizes III and V and motion and matrix perimetry. *Arch Ophthalmol* 2010;128:570-6.
21. Spry PG, Johnson CA. Senescent changes of the normal visual field: an age-old problem. *Optom.Vis.Sci.2001.Jun.* 1978;436-41.
22. Bengtsson B, Heijl A. Inter-subject variability and normal limits of the SITA Standard, SITA Fast, and the Humphrey Full Threshold computerized perimetry strategies, SITA STATPAC. *Acta Ophthalmol Scand* 1999;77:125-9.
23. Phu J, Khuu SK, Nivison-Smith L, Zangerl B, Choi AYJ, Jones BW et al. Pattern Recognition Analysis Reveals Unique Contrast Sensitivity Isocontours Using Static Perimetry Thresholds Across the Visual Field. *Invest Ophthalmol Vis Sci* 2017;58:4863-76.
24. Rutkowski P, May CA. The peripheral and Central Humphrey visual field - morphological changes during aging. *BMC.Ophthalmol.* 2017;17:134-0522.
25. Phu J, Bui BV, Kalloniatis M, Khuu SK. How Many Subjects are Needed for a Visual Field Normative Database? A Comparison of Ground Truth and Bootstrapped Statistics. *Transl.Vis Sci Technol.* 2018;7:1-11.

Figures

Figure 1.

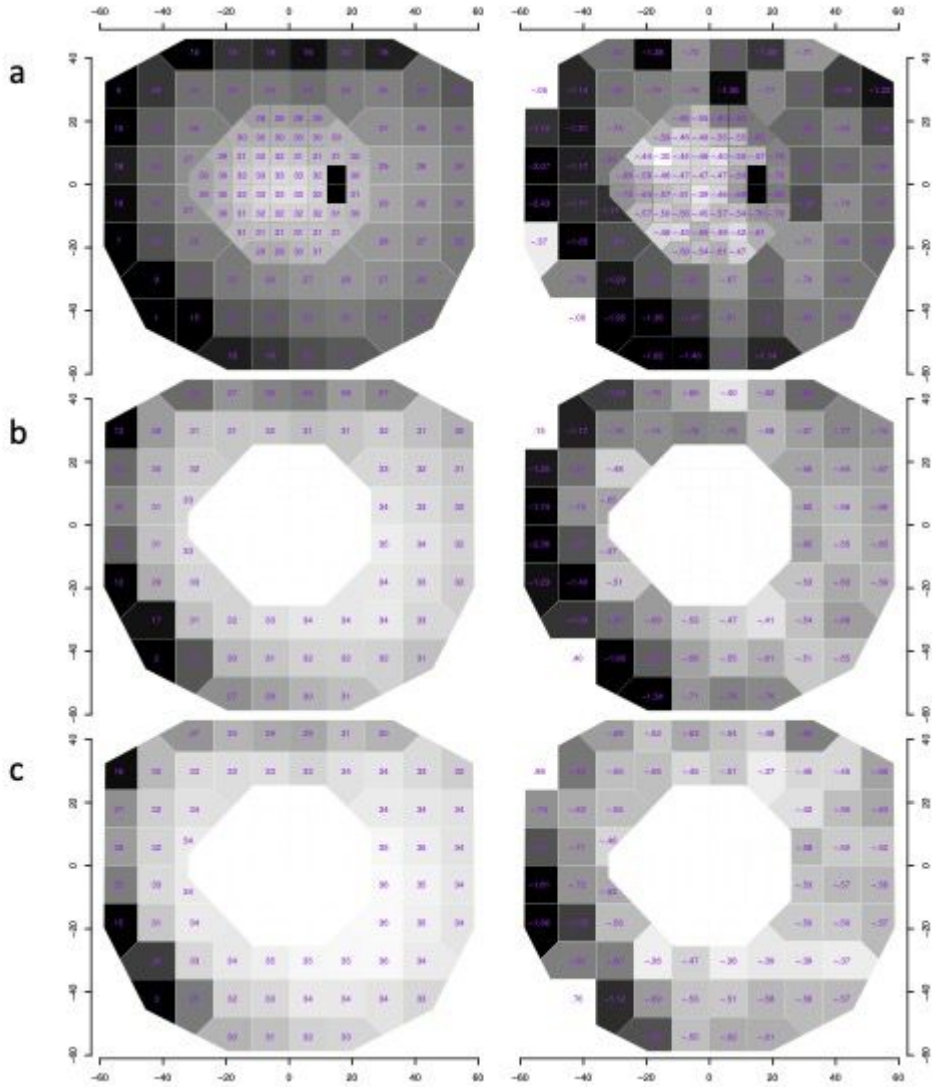

Figure 1

Pointwise mean normal sensitivities (in dB) and slopes (in dB per decade) for the 30–2 and 60–4 tests for Goldmann size III (top) size V (middle) and size VI (bottom).

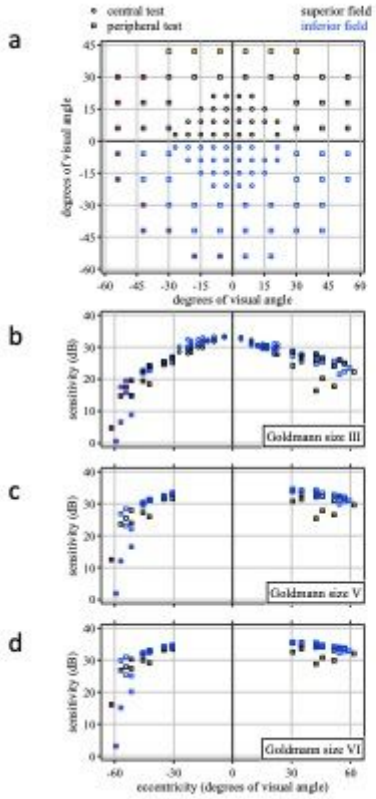

Figure 2.

Figure 2

Relationship of the age-corrected sensitivity vs visual field eccentricity for 0° – 60° for Goldmann size III and for the 30°–60° for sizes V and VI. The graph at the top shows test point locations in degrees of visual angle.

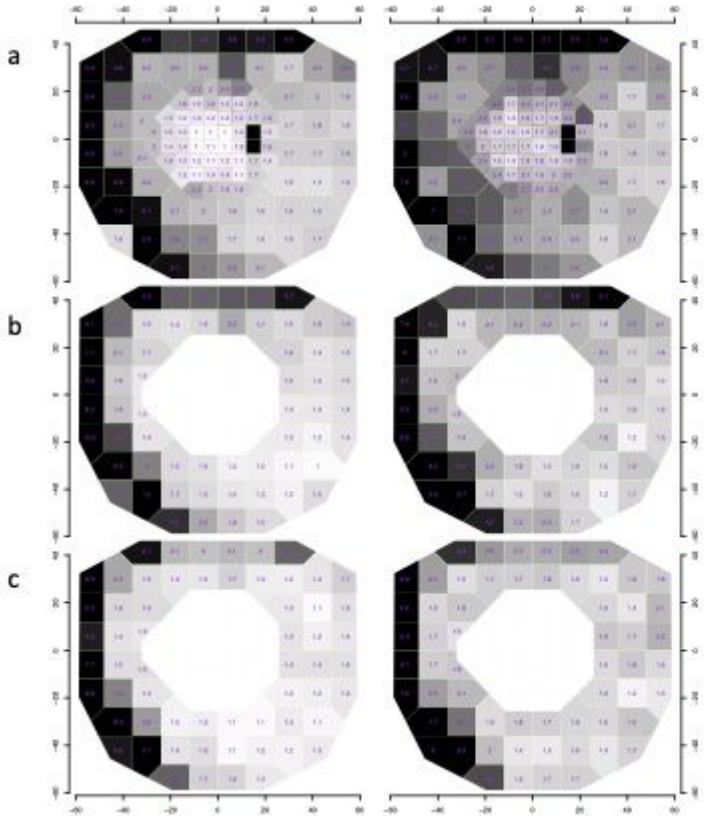

Figure 3.

Figure 3

Pointwise between-subject standard deviation (left) and within-subject standard deviation (right) for the 30–2 and 60–4 tests with (a) Goldmann size III, (b) size V and (c) size VI.

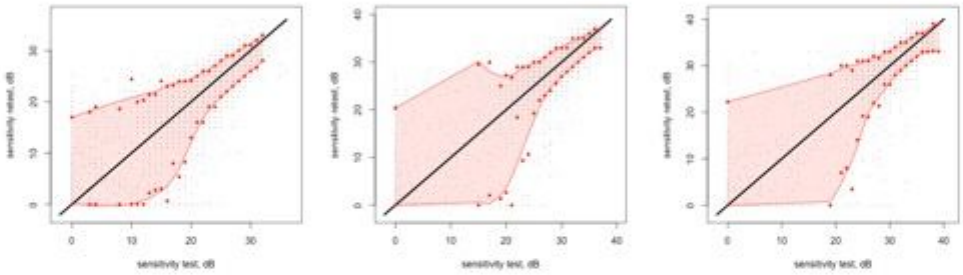

Figure 4.

Figure 4

Conditional test–retest distribution and lower and upper variability limits established from the empiric 5th and 95th percentiles for Goldman size III (left), size V (middle), and size VI (right). Note the acceptable reproducibility for all stimulus sizes above about 25 dB.

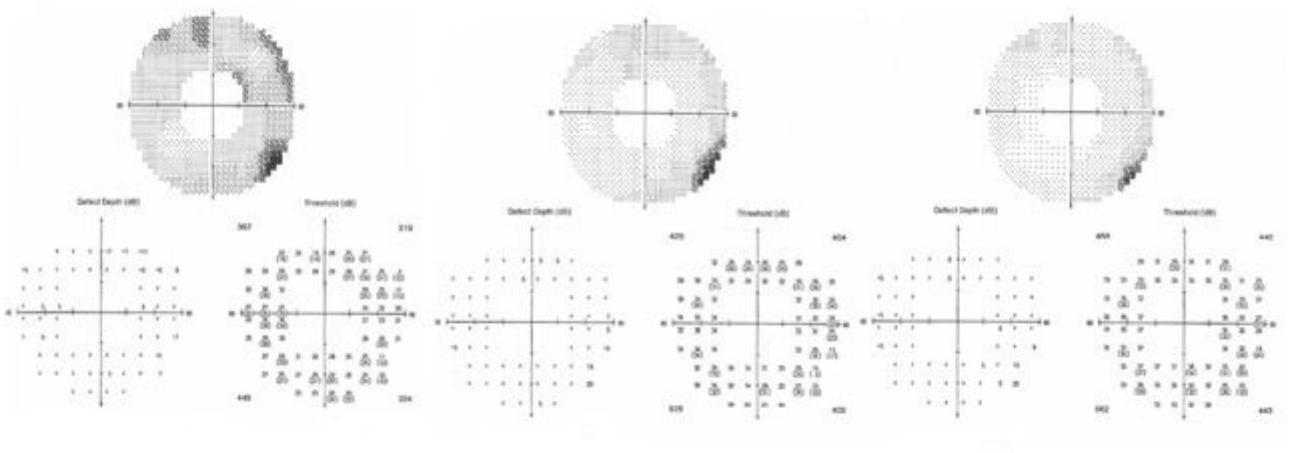

Figure 5.

Figure 5

Individual 60-4 size III, V and VI printouts from a subject with a deep-set orbit structure.

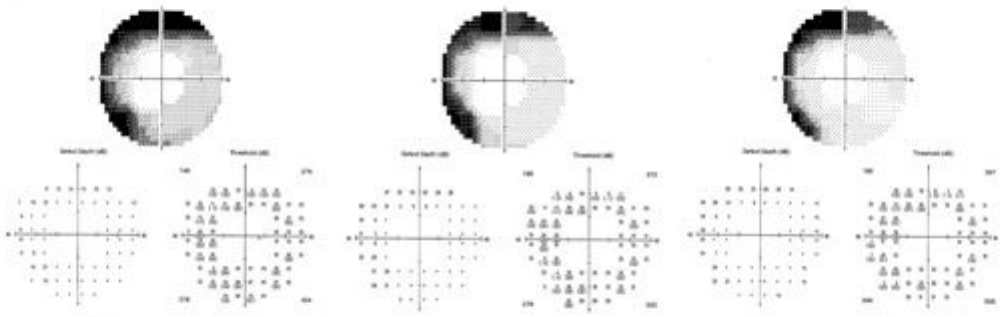

Figure 6.

Figure 6

Typical 60-4 size III, V and VI printouts from a subject's left eye showing the common mid-inferonasal depression.

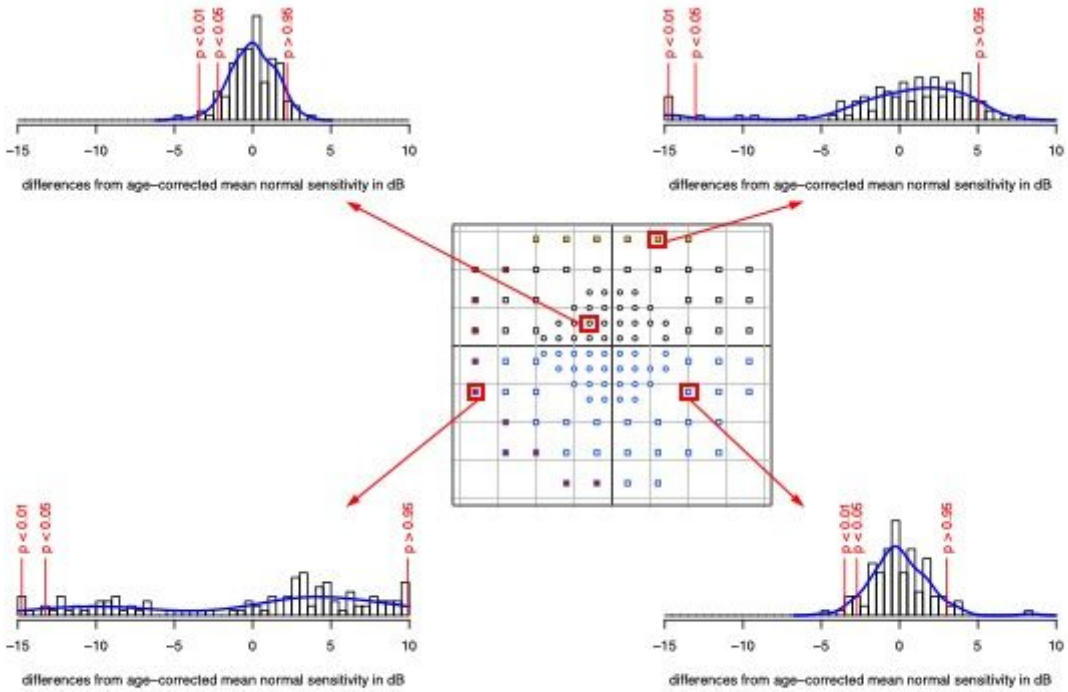

Figure 7.

Figure 7

Examples of representative histograms of differences from age corrected mean normal values at various visual field eccentricities. Note that the variability of the inferotemporal test location is similar to the 24-2 location and the variability of the far superior and far nasal test locations is very high.