Threshold Automated Perimetry of the Full Visual Field in Glaucoma Patients with Mild Visual Loss


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SAP of the Full Visual Field in Glaucoma
Precis: We used the Open Perimetry Interface to design a static automated perimetry test of the full field. Abnormal test locations in the nasal midperiphery and temporal inferior sector area best separated glaucomas from normals.

Disclosure: The authors declare no conflict of interest.
Abstract

Purpose: The peripheral visual field in glaucoma outside 30° is largely unexplored with static perimetry. Our goal was to use threshold static automated perimetry to characterize the visual loss in glaucoma of the central 30° and the far periphery.

Patients and Methods: We administered our 30-2 perimetric test to 27 early stage (with mean deviation better than -4 dB) glaucoma patients with the Goldmann III and V stimulus sizes and a custom test from 30° to up to 87° with the size V stimulus twice within a month. We quantified 1) the retest variability, 2) the proportion of patients flagged as abnormal (at level 0.05) based on pointwise probability distributions obtained from 63 ocular healthy observers, 3) the pointwise statistical distance using the Kullback-Leibler divergence between normal and glaucoma eyes and 4) the effect of eccentricity on visual loss.

Results: Size V 30-2 testing identified significantly more abnormal test locations (36%) than size III 30-2 (30%; p = 0.004). Kullback-Leibler divergence between healthy and glaucoma distributions was greatest for the nasal mid-peripheral test locations and the inferior temporal sector area. We found a more pronounced decrease in visual sensitivity with eccentricity in the glaucoma patients compared to the ocular healthy participants across the full visual field (p < 0.001).

Conclusion: Glaucoma patients demonstrate a systematic decrease in sensitivity with eccentricity across the full visual field. Goldmann size V stimuli better detected visual loss in glaucoma patients with mild loss than size III.

Key Words: glaucoma, perimetry, visual field, vision testing
Introduction

The peripheral visual field is largely unexplored to a sensitive type of testing – static threshold automated perimetry. Until the advent of computerized perimetry in the late 1970s, clinical practice was to test the full limits of the visual field manually by kinetic Goldmann bowl perimetry. With the evolution to computerized threshold automated static perimetry, most glaucoma clinics now test the central 21° (24-2 test pattern) and may supplement the testing with a 2° spaced grid of the central 10 degrees (10-2 test pattern); yet the visual field territory outside of the central 30° is seldom being tested. This untested area outside the central visual field represents over 3 times the area currently being evaluated centrally.

There are few published studies using standard automated perimetry (SAP) outside of 30°. Brenton and Phelps\(^1\) using 102 healthy observers, investigated perimetry thresholds in both the central 30° and the 30 – 60° field using the size III (0.43° diameter) stimulus with the full threshold staircase strategy. They found a gradual decline in sensitivity across the visual field and decreasing sensitivity with age. They also noted a higher variability in the area outside 30°.

Fechtner and coworkers\(^2\)\(^-\)\(^3\) tested the visual field from 30 – 60° with a Humphrey Field Analyzer 60-4 program apparently with a size III stimulus (not specified). The 60-4 test estimates thresholds for 60 test locations with grid spacing of 12° from 30 – 60°. They noted high variability in the outer ring of test locations of the 60-4 superiorly and nasally.

Caprioli and Spaeth\(^4\) tested the central 30° with SAP and added test locations spanning 20° along the nasal horizontal meridian in 97 consecutive primary open-angle glaucoma patients. They reported that 11% of cases had abnormalities along the nasal horizontal meridian with no defect in the central visual field.

Issues that limit testing outside 30° of the visual field are that with the size III stimulus, retest variability is often high, and the test is tedious and difficult for the subject mostly due to the small stimulus size. We have shown for the central 24° visual field, use of the Goldmann size V stimulus detects visual field defects just as well as using the size III stimulus\(^5\)\(^-\)\(^6\). However, the Goldmann size V stimulus has the
drawback that the energy steps in the thresholds are larger than for a Goldmann size III, effectively making it more likely to obtain a repeatable result at the expense of a more coarse sensitivity scale. The use of the Goldmann size V stimulus is also supported by the fact that it is less affected by refractive error. Also, this stimulus is easier for the subject to attend to, especially in the far periphery of the visual field. Unfortunately, there are no Bayesian strategies with dynamic timing available commercially to rapidly test the far periphery.

To explore the far periphery in glaucoma patients, we used the Open Perimetry Interface\(^7\) to develop testing strategies for the central and far peripheral visual fields. We employed the Goldmann size III (0.43° diameter) and size V (1.73° diameter) stimuli for the central visual field and the size V stimulus for the far periphery. A Bayesian testing strategy with dynamic timing was implemented based on ZEST.\(^8\)

Figure 1 shows the central (filled circles) and far peripheral (open circles) test locations used. We first tested 63 healthy observers twice and developed pointwise probability plot limits. We then tested the central and far peripheral field of one eye twice in 27 patients with mild glaucoma (mean deviation better than -4 dB). Our aim was to validate the new OPI tests and characterize visual loss across the visual field in glaucoma patients with mild visual loss. This included comparisons of retest variability, defect depth, statistical distances between ocular healthy participants and glaucomas and the relative number of abnormal test locations among the three tests.

Methods

The Open Perimetry Interface (OPI) is open-source software used to interface with visual field testing machines (perimeters). It allows creation of central and peripheral visual field tests running on the Octopus 900 perimeter.\(^7\) To test the central field, test locations were positioned on a Cartesian coordinate system with a six-degree spaced grid inside 30°, matching the 74 test locations of the 30-2 pattern of the Humphrey Field Analyzer (Carl Zeiss, Dublin CA). To test the peripheral field outside 30°, test locations utilize a 12° spaced grid based on coverage and retest variability. For example, test locations superiorly and nasally were eliminated because of poor retest variability due to edge effects
from the eyelid and brow superiorly and the nose nasally. As a result, the peripheral test involved 84 total
test locations and spanned 51° nasally, 51° inferiorly, 39° superiorly, and 87° temporally (Figure 1).

A ZEST strategy employing a bi-modal prior, default likelihood function and a stopping criteria of a
standard deviation of 1.5 dB coded from the OPI was used.\(^8\) The peak of the prior distribution for each
location was seeded from adjacent test locations, thus primary seed locations towards the center of the
field were presented first (in random order) followed by non-primary seed locations with higher
eccentricity as their neighbors became available as seeds. At each location, the starting bi-modal prior
probability mass function consisted of one peak at 15 dB, and a second peak which is set at either a pre-
determined value if it is a primary seed location or the average sensitivity of its direct neighbors if it is a
non-primary location.

Primary seed locations were assigned a starting value which was determined empirically from data
obtained in an earlier preliminary study. For the 30-2 test pattern, the second peak was centered on 28 dB
for size III and 33 dB for size V. For the peripheral field, the second peak was centered on 31 dB. The
procedure was truncated at 15 dB and estimated sensitivities below 15 dB were censored and assigned the
value −1. Our stimulus presentation time was 200 msec. We implemented an adaptive response window
which changes accordingly based on the observer’s individual response time and is sensitive to how it
may fluctuate during the examination. The response window was calculated as response window (ms) =
mean of the last 5 response times + 250 ms.

Inclusion of the 250 ms pedestal ensured that a lower limit for the response window was established and
to allow the response window to widen if the observer’s response time is significantly slower than the
average of the last 5 responses. Upon commencement of the test, we automatically set the last 5 responses
to be 1200 ms. The pool of 5 responses from which the average is calculated was updated with each new
response.

In addition to an adaptive response window, we also implemented an adaptive inter-stimulus interval. The
inter-stimulus interval is calculated as a randomly generated value between 300 ms and the observer’s
mean response time, multiplied by a predetermined constant.
Upon test completion, an algorithm was run to detect test locations that were statistical outliers compared to neighbors and these locations were retested, with the retested result being used as the final threshold. False responses were monitored with catch trials during the test.

Subjects The visual testing protocol was approved by the University of Iowa institutional review board and followed the tenets of the Declaration of Helsinki. Sixty-three ocular healthy observers and 27 glaucoma patients were tested at 2 separate sittings within a 4-week period. They all gave written informed consent to participate in the study. The healthy observers were volunteers, paid following a protocol approved by the Investigational Review Board. The volunteers answered advertisements inviting them to participate in research. The glaucoma patients were invited from the glaucoma clinic at the University of Iowa Department of Ophthalmology and Visual Sciences. The average age of the healthy observers was 46.4 with a SD of 17.8 years; ranging from 18 to 78. The average age of the glaucoma patients was 66.1 with a SD of 9.1 years; ranging from 26 to 76.

Healthy observers were included if they had 1) no history of eye disease and modest refractive error (no more optical correction than 5 diopters of sphere or 3 diopters of cylinder), 2) no history of diabetes mellitus or systemic arterial hypertension, and 3) a healthy ophthalmologic examination including 20/25 or better corrected Snellen acuity. The subjects either had undergone a complete eye exam within 2 years prior to this study or were examined by an ophthalmologist on the day of testing. A perimetric examination was specifically not required.

Glaucoma patients treated at the University of Iowa Hospitals and Clinics Glaucoma Service were offered study admission if they met entry criteria. They were enrolled if they had glaucomatous optic disc changes with abnormal conventional automated perimetry (glaucomatous visual field defects, i.e., three or more adjacent abnormal test locations in a clinically suspicious area at the $p < 0.05$ level or two adjacent locations abnormal with at least one at the $p < 0.01$ level). In addition, only those with mild glaucomatous visual field loss were eligible [mean deviation -4 dB or better on a 24–2 Swedish Interactive Threshold Algorithm (SITA) standard test]. We included patients with primary, secondary, and normal tension glaucoma. The patients did not have another disease affecting vision and were capable of reliably
performing conventional automated perimetry and returning for follow-up visits. Patients were excluded if they had cataract causing visual acuity of worse than 20/30, pupil size less than 2.5 mm, age less than 19, or were pregnant at the time of study entry. Most of the glaucoma patients had prior experience with static automated perimetry; most of the healthy observers were naive perimetry subjects; any subjects that had difficulty with the initial test were given a practice test.

Visual Testing Participants completed two visits within 4 weeks where they were given four static automated perimetry tests: OPI 30-2 size III, OPI 30-2 size V, OPI peripheral size V, and OPI peripheral size VI (although the data for the size VI test is not shown in this paper). The order in which the four tests were administered was randomized. For the central field tests, we followed standard recommended testing procedures and used a corrective lens when necessary (all but two glaucoma patients). Unlike the size III stimulus, the size V stimulus is relatively robust against blur. Care was taken to prevent lens rim artifact. Corrective lenses were not used for the peripheral field tests. The healthy participants had testing in one eye chosen at random and the same eye was used for all four tests. The glaucoma patients had one eye chosen that qualified for the study. If both eyes qualified, one eye was chosen at random. All visual field testing met the following reliability criteria: a false positive rate of less than 33\% and a false negative rate of less than 33\%. A visual field technician monitored gaze and participants that did not maintain good central fixation during the examination were excluded.

Data Analysis We performed 4 analyses to compare the three visual field types, OPI 30-2 size III, OPI 30-2 size V, and OPI peripheral size V.

First, we examined test-retest variability plotting sensitivity values of each location of the second test as a function of the value in each location of the first test. At each dB level on the x-axis, we obtained the 5th and 95th empirical percentile and fitted locally linear, loess curves as a means to estimate the quantiles as functions of dB level that leave the 90\% retest conditional distribution.

Second, we used the CRAN R visualFields package, to obtain pointwise linear age models and empirical probabilities using the two repeated tests of the healthy subjects. The age models were used to obtain total-deviation maps, where the pointwise sensitivities of a single visual field test are subtracted the
mean normal age-corrected sensitivities for a person of the same age. The empirical probabilities were used to derive total-deviation probability maps. Since our database of normals is based in 60 subjects tested twice, we then only quantified the number of test locations with loss with a percentile lower than 5% level. Two-sided paired Wilcoxon signed rank significance tests were performed with the null hypotheses that the proportions of locations below the 5th percentile are equal for the pointwise comparisons OPI 30-2 size III versus size V, OPI 30-2 size V versus peripheral size V, and OPI 30-2 size III versus peripheral size V.

Third, to examine which locations might best separate glaucoma and control group, we calculated the Kullback-Leibler divergence (KLD) between the distributions of total deviation values for each location in each population. We used KLD because the distributions of TD values have different central tendencies, shape and spread in the two populations, so results from standard parametric comparisons would be likely biased. To determine significance, or otherwise, of the KLD we used bootstrapping with 1000 replications to obtain confidence intervals on the distances.

Finally, we assessed the differences in eccentricity effects between healthy subjects and patients with glaucoma from linear regression of the age-adjusted sensitivity on the square of the Euclidean distance of each location from the fixation point. We squared the distance because its association with sensitivity has been shown to be more linear than for distance itself.\textsuperscript{13} Significance test for equal slopes\textsuperscript{14} between healthy subjects and patients with glaucoma were computed separately for the nasal and the temporal hemifields.

**Results**

The participants’ average test times for each testing strategy are found in Table 1. As expected, testing times were longer in the glaucoma patients compared to the healthy observers.

Test times in the far periphery algorithm were longer than 30-2 testing as there were 10 more test locations, and the greater eccentricities also introduced delays due to the mechanics of the light projection. The false positive and false negative catch trial rates are found in Table 2. Test-retest
performance for the healthy observers and the glaucoma patients are found in Figure 2a-c. The region representing 90% of the retest conditional distribution as a function of dB level is shadowed in red. The region is smaller for stimulus size V than for size III indicating better repeatability. The distortions of the loess fit below about 20 dB are likely due to outliers caused by lid and brow artifacts and edge effects.

We found the following percentages of abnormal test locations comparing the tests: 30% for the OPI 30-2 size III, 36% for the OPI 30-2 size V, and 31% for the OPI peripheral size V tests. After Bonferroni correction, the proportions of locations below the 5th percentile were significantly greater for the 30-2 size V test than for the 30-2 size III test (p = 0.004). These proportions were not significantly greater for the peripheral size V test than for the 30-2 size III test (p = 0.55) or for the 30-2 size V test (p = 0.13).

The average defect depth of glaucoma patients compared to our 63 healthy subjects across the visual field for size V and the 30-2 III test is found in the heat map of Figure 3. Notice how defect depth (red) increases in the periphery with eccentricity, especially in the far nasal visual field. The defect depth appears greater with size III than with size V. The Kullback-Leibler divergence, used to evaluate which test locations best separated healthy observers from glaucoma patients, shows the best separation, however, occurs in the nasal mid-periphery, especially superiorly (see red areas in Figure 4). Other important areas for separation are the peripheral inferior temporal sector and the nasal far periphery.

Similarly, Figure 5 shows a pattern that is similar to the Kullback-Leibler divergence by displaying the proportion of glaucoma patients with total deviation probability level of 5% level or lower and highlights the importance of the nasal mid periphery and the inferior temporal sector region.

Figure 6 shows sensitivities (adjusted to age 45) as a function of eccentricity (a) and of eccentricity squared (b) for healthy subjects (empty symbols) and patients with glaucoma (in red). Temporally, sensitivities decreased by about $1.27 \times 10^{-3}$ dB and $1.40 \times 10^{-3}$ dB per degree$^2$ of eccentricity for healthy subjects and patients with glaucoma respectively. Nasally the corresponding values were $2.52 \times 10^{-3}$ dB and $4.27 \times 10^{-3}$ dB per degree$^2$ of eccentricity. The sensitivities for the patients with glaucoma decreased
faster than with healthy subjects nasally (by $1.75 \times 10^{-3}$ dB per degree$^2$, $p < 0.001$) and temporally (by $0.13 \times 10^{-3}$ dB per degree$^2$, $p = 0.21$).

To further investigate this eccentricity effect, we used a Bland-Altman plot of the mean deviation of the central visual field minus the mean deviation of the peripheral field (Figure 7). This shows the periphery having greater negative mean deviation than the central field.

**Discussion**

The far peripheral visual field using static automated perimetry is largely unexplored. This is likely because the Goldmann size III stimulus has been used in the past for threshold testing of the far periphery. The reasons for standardizing on size III for SAP are unclear. It appears to be a compromise between the size I stimulus, that is very prone to refractive error, and size V, that was thought too insensitive for defect detection. However, we have found use of the size V stimulus in glaucoma patients to give as good a detection rate of visual field defects as using the size III stimulus.$^5,17$ Due to the lower retest variability and greater salience in the far periphery of size V, we used this stimulus to test both the center and far peripheral visual fields using the Open Perimetry Interface.$^7$ The benefits of using the size V stimulus to test the central and peripheral fields are apparent from the data in Figure 2 – this large stimulus size is salient in the far periphery, is robust against refractive error and improves the useful dynamic range of the test.

Previous reports comparing stimulus sizes III and V in the central visual field have shown there is little difference in these stimulus sizes to detect visual field defects.$^5,17$ While the depth of the defect appears to be greater with the size III stimulus (Figure 3), there is a substantially better retest variability using the size V stimulus; this property likely accounts for its similar performance to detect visual field defects. In addition, it has been shown that there is almost one more log unit of useful dynamic range with the size V stimulus.$^6$ And there is improved useful dynamic range for detecting progression using the size V stimulus.$^{15}$
With our new tests, we found that there were approximately as many abnormal test locations flagged in the far periphery as in the central visual field using the size V stimulus. We also found that the depth of the visual field defect increased with visual field eccentricity. However, the test locations to give the best statistical separation and those with the most frequent probability plot abnormalities were in the midperiphery of the nasal field especially superiorly (Figures 4 and 5) rather than the far nasal periphery where the depth of the defect is greatest (Figure 3). This likely relates to the higher variability in the far peripheral locations due to nose, lid and brow-related artifacts. Another important area for statistical separation of glaucoma patients from normals is the inferior temporal sector region. Temporal wedge defects in this region were common in our glaucoma subjects. We have shown a similar number of these temporal wedge defects in idiopathic intracranial hypertension, also using our OPI perimetry software. Incorporating a Bayesian strategy with dynamic timing similar to SITA enabled us to develop a test with a reasonable test time coupled with acceptable reliability criteria. The results from 30-2 testing were similar to SITA Standard test times. However, if both a central and a peripheral test were to be done, the combined test time would be longer than would be expected simply from a SITA Standard 24-2. We have addressed this in version 2 of the software. With this improved version, each of the central and peripheral visual field examinations takes 6-7 minutes. We also have developed an OPI suprathreshold screening test based on the threshold test that takes about 3 minutes each to flag the 1% and 5% pointwise probability plot cutoffs that are based on the results from 98 normal subjects tested twice. Since we used the Open Perimetry Interface for this study, the software is available upon request.

We anticipate that this full-field threshold test will have utility in several ways. First, by adding the far periphery, showing more of the full extent of any deficits gives a more comprehensive assessment of the subject’s visual loss. For example, about half of the subjects had localized loss in the inferotemporal sector (an area important for navigating the environment); our experience to date is there is very good agreement with the related OCT deficits. Second, defects may be found in the far periphery or with little loss in the central visual field.
As demonstrated in Figure 2, using the size V stimulus for the central and peripheral visual field examinations results in acceptable retest variability when sensitivities are better than about 20 dB. This finding is similar to other studies examining the retest variability of the size V stimulus.\textsuperscript{15, 17, 22}

As expected, we found that in healthy participants there was a systematic decrease in sensitivity with increasing eccentricity. A new finding is that glaucoma patients with mild visual loss there is also a systematic decrease in sensitivity and when compared to normals, this falloff in sensitivity is accelerated with eccentricity and involves the full visual field. Even though the association between square distance and age-adjusted sensitivities is more linear than with distance itself, it is clear from Figure 6 that the decrease is not perfectly linear over the whole range (in particular, in the temporal hemifield, after 75° of eccentricity, linearity appears to break down). Nevertheless, the departures from linearity do not appear to be large. While there are many localized defects in glaucoma, they appear to be distributed relatively evenly by eccentricity in this cohort of glaucoma with mild visual loss. In addition, the nasal visual field had a greater rate of decline than other areas of the visual field. This may have implications for placement of test locations in patients with glaucoma with mild visual loss.

While we found an increase in defect depth with eccentricity, it is well known that glaucoma has both localized and generalized visual field defects.\textsuperscript{24, 25} Therefore, even though the superior field is somewhat more damaged than the inferior field, the localized losses must be dispersed across eccentricities for this pattern of increasing loss with eccentricity to occur.\textsuperscript{26, 27}

As shown in Figure 3, we found a greater defect depth with the size III compared to the size V stimulus, at least in the central field. This relationship between smaller size and greater defect depth in glaucoma has been reported by others.\textsuperscript{28, 29} Kalloniatis and Khuu\textsuperscript{28, 30} conclude, due to spatial summation, that this is because smaller stimuli fall within Ricco’s area and suggest using the largest Goldmann stimulus size that falls within or at Ricco’s area. Use of a size V stimulus for glaucoma overcomes this limitation due to its lower variability. This allows size V to perform at least as well as size III for defect detection using empiric pointwise probability plots.\textsuperscript{5, 17}
Another potential confounding issue is that a corrective lens is used for central visual field testing but not for the periphery. Is it possible that the reduction in sensitivity with eccentricity is greater for glaucomatous eyes than normal eyes since normal eyes would be more likely not need refraction? We do not think this issue explains the increase in visual field loss with eccentricity. While uncorrected refractive error can definitely influence measured sensitivity, Anderson and coworkers have shown larger stimuli are relatively unaffected by defocus when stimulus size reaches 1.6 degrees. With stimuli larger than this they found little or no increase in threshold for refractive error between ± 4.00 diopters. Since the size V stimulus is 1.72 degrees, inadequate refraction causing measurement error is not likely to be large.

Limitations of our study include its small sample size, limited applicability to glaucoma patients with mild damage, and lack of longitudinal testing. By using a sample of at least 10 healthy observers per decade for our control sample, it should be mentioned that the average age of this sample was considerably younger than the glaucoma population; this age-stratified sample was necessary to develop age standardization when developing the pointwise probability plots. A future manuscript will investigate the patterns of visual loss with the size V stimulus and correlation of the defects found with OCT.

With regard to using this full-field strategy in clinical practice, like glaucoma, treatment in idiopathic intracranial hypertension patients becomes more aggressive with the presence or the worsening of visual loss. The visual loss we found with threshold full-field testing often occurs only peripherally or maximally in the periphery in idiopathic intracranial hypertension. Finding more severe visual loss in the periphery would prompt clinicians to be more aggressive with their therapy.

In summary, we found testing of the full visual field with threshold static automated perimetry can be performed in a practical and efficient manner and may have a place in the evaluation of glaucoma with mild visual loss. We found a systematic decrease in sensitivity across the visual field in healthy participants and a more prominent systematic increase in the rate of dB loss in the far periphery especially nasally. Test locations in the nasal mid periphery and inferior temporal sector were shown to have the best statistical discrimination between cases and healthy observers. The Open Perimetry Interface is a useful platform to develop and test new perimetry methods and can be used to develop an efficient and repeatable threshold automated perimetry test of the full visual field.
Figures

Figure 1. Test locations for the central (blue) and far peripheral (black) tests.

Figure 2. Point-wise limits of test-retest variability established from the empiric 5th and 95th percentiles of the distribution of retest values, stratified by the value of the first test. Red lines indicate the location of the empiric 5th and 95th percentiles. Because empiric percentiles are difficult to estimate precisely from small samples, the retest intervals were estimated by Lowess smoothing (shaded areas between the lines connecting the 5th and 95th percentiles). For each dB level in the x-axis, at least 20 values were required to obtain the 5th and 95th percentile or the line is not drawn. Individual data points are shown as scattered dots with slight jitter to improve visibility. Figure 2 a, left shows 30-2 size III results for normals and glaucomas (right). Figure 2 b, left shows 30-2 size V results for normals and glaucomas (right). Figure 2 c, left shows peripheral size V results for normals and glaucomas (right).

Figure 3. Heat map of the mean depth of the defects across the visual field for stimulus size V in dB. Note the increase in defect depth with eccentricity, most pronounced nasally. Red indicates areas of most loss, yellow intermediate and blue least.

Figure 4. Heat map showing the Kullback-Leibler divergence between the distribution of sensitivity values at each location for the healthy observers and glaucoma groups. The higher the number, the greater the distance (separation); red has most separation and blue least.

Figure 5. The proportion of glaucoma patients with a total deviation probability level of at most 5%. Values below 35% are in light blue. Above that value, they follow the yellow-orange-red color scheme with red values being greatest.

Figure 6. a) Mean sensitivities (adjusted to age 45) as a function of (a) eccentricity and (b) square distance from fixation for healthy observers (empty symbols) and glaucoma (red symbols).

Figure 7. Bland-Altman plot of the mean deviation of the central field minus the mean deviation of the peripheral field (below). This shows the periphery having greater negative mean deviation than the central field.
References


Table 1. Average test times for the participants (minutes:seconds).

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<th>30-2 III</th>
<th>30-2 V</th>
<th>Peripheral V</th>
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<td>5:14</td>
<td>10:13</td>
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<tr>
<td>Glaucomas</td>
<td>12:10</td>
<td>7:51</td>
<td>13:04</td>
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Table 2. Results of catch trials with the different examinations and groups in percent showing mean and standard deviation.

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<th>Group</th>
<th>30-2 III</th>
<th>30-2 V</th>
<th>Peripheral V</th>
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<td><strong>Normals</strong></td>
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<td></td>
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<tr>
<td>False Positives</td>
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