

Rarebit Perimetry, Version 4

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1. Design principles

Rarebit Perimetry was devised with the express aim to improve diagnosis of low-degree neural damage. Conventional perimetry is known to have a high threshold for detectable damage. Conventional perimetry also suffers from an immense variability. Rarebit Perimetry addresses these issues directly and involves a complete departure from conventional testing principles. The new test is simple, fun, fast, robust, and user-friendly. Results are expressed as plain percentages of normal and are plotted in an intuitively understandable format. The test design ensures minimum interference by cataract and other optical faults.

The test principle is to probe the integrity of the retinal architecture. Although the retinal architecture is immensely complicated, and much remains to be learned, a simple model can be sketched using receptive fields. A receptive field is defined with reference to a retinal ganglion cell as that retinal area from which the ganglion cell can be stimulated. Normally, receptive fields tile the retina completely, without overlaps or gaps. There are several, specialized types of receptive fields. The Rarebit Test is thought to target one of these types, namely, the midget fields. The midget ganglion cells are by far the most numerous of all ganglion cells and are held to mediate finely detailed vision, e.g., resolution.

In the following, retinal ganglion cells and their upstream connections will be referred to as retino-cortical neural channels or simply channels. Loss of midget channels can be envisaged to interfere with finely detailed vision, by causing the appearance of gaps or holes in the neural matrix.

The spatial subtense of midget receptive fields is generally very small in relation to ordinary perimetric test targets. Hence, the small gaps formed by loss of midget cells may be difficult to detect. Indeed, experimental and clinico-pathological studies have shown that damage is not detectable until

about one-quarter to one-half of all channels have been compromised. A possible interpretation is that it is first with these magnitudes of damage that receptive field gaps coalesce densely enough to affect sensitivity to standard perimetric targets. Expressed in another way, ordinary perimetric targets hold such an excess of information that they can be detected even by partially depleted neuro-retinal mosaics.

The prospects of detecting small degrees of damage should be better using stimuli holding a bare minimum of information, both in space and time. In Rarebit Perimetry, the information is carried by pairs of minuscule bright dots ("bits"), very briefly presented against a dark background. The number of dots is very small ("rare bits"), hence the colloquial test name, "The Rabbit Test". Actually, the test could very well depend on presentations of single "micro" dots. However, in a clinical setting, the use of pairs of dots is advantageous: this appears to strike an optimum compromise between rates of information transfer and interface complexity. It also makes for a quick and interesting test task and facilitates control of response quality.

As mentioned above, the immense variability of conventional perimetry forms an important barrier to diagnosis: normal limits are wide enough to envelop substantial degrees of damage. Normal variability goes back to a multitude of sources, including actual anatomical variation between individuals and variations inherent in threshold measurements. Rarebit Perimetry circumvents these sources of variation, by testing integrity of organization rather than level of function, and by avoiding thresholding. In the present context, integrity of organization means that normal retinas are completely tiled by receptive fields. Tiling is equally complete in individuals who have relatively small numbers of receptive fields as in individuals who have relatively large numbers of receptive fields. Therefore, checking the completeness of tiling, as done in Rarebit Perimetry, is independent of actual receptive field numbers. Every normal eye should see 100% of the probes (or nearly so: provision has to be made for the blind spot and angioscotomata). This makes for very narrow normal limits (see further).

There are two important physical requisites for the rarebit approach. First, the retinal images of light spots should be small in relation to receptive field size. Otherwise, one and the same dot image may involve more than one receptive field. Further, if multiple dots are used, their separations must be larger than receptive field sizes.

Ideally, the light spots, or rather their retinal images, should be point-size. This ideal is presently not possible to realize in clinical settings. Instead, an upper limit on size has to be defined, which strikes a useful compromise between the imaging characteristics of the eye's optical system and the working apertures of receptive fields. A first estimate of maximum sizes (and minimum separations) can be obtained from published resolution data, as minimum angles of resolution (MAR). For example, for probing at 5 degrees of eccentricity, dot size should not exceed normal MAR at 5 degrees, or

approximately 2 minutes of arc (= stroke width in 20/40 optotypes [0.5 decimal]). If probes are to be carried out to, say, 30 degrees of eccentricity, where MAR approximates 6', minimum dot separation equals the latter value. Much larger separations make for a much easier test task.

Rarebit Perimetry scales dots according to normal MARs. Contrast, on the other hand, is kept constant and is set to a high, supraliminal level. Hence, contrast is not a limiting factor in Rarebit Perimetry. Incidentally, the reason for using bright dots on a dark background is to maximize image contrast.

The second physical requisite concerns presentation time. This should be short enough to "freeze" the optical dot image relative to the receptive field matrix, to prevent eye movements from sweeping receptive fields across the dot image. Clearly, sweeping may allow defective matrices to produce falsely good results. Involuntary sweeping occurs in even the most steadily fixating eyes. Hence, exposure times should be brief.

Provided that contrasts and separations are large enough, a normal eye can easily recognize a pair of dots everywhere in the visual field, except in the blind spot and in angioscotomata. On the other hand, an eye with a partially depleted neural matrix cannot consistently manage this task. Actually, chances to see both dots in a pair will drop with increasing channel loss: depending on the degree of damage, the subject might see just one dot or none at all. Because the Rabbit Test jitters target positions, repeated presentations will involve ever-new receptive field positions. Hence, on multiple presentations, the subject might sometimes see two dots, sometimes one, and sometimes none. Outcomes will be different for different degrees of damage and can be calculated theoretically. Click on Probability plot in the Contents menu (top left) to see a diagram of these relationships. Click on Simulations to run a dynamic demonstration.

The test dots are contained within 24 rectangular areas, which tile the central field between 4 and 28 degrees of horizontal eccentricity. The rectangular areas increase in size from 6 x 8 degrees centrally to 6 x 14 degrees peripherally. This is to keep the proportion of sampled receptive fields at a constant level (in normal eyes). The number and distribution of test areas is calculated to provide optimum detail for clinical diagnosis.

One and the same test pattern is used for right and left eyes. The pattern is traversed repeatedly. The number of repeats is governed by the desired precision of measurement (see further).

The test dots are presented in pairs. The dot separation equals 4 degrees within each pair. It is the large dot separation that keeps influences from any optical faults at a minimum. The dot pairs are oriented either horizontally or vertically, never obliquely. This is to avoid the so-called oblique effect. The dot pairs are evenly distributed within each rectangular test area. Minimum separation between tested locations equals 1 degree.

The Rabbit Test does not monitor fixation. This saves time and spares the examiner the difficulty of evaluating fixation data. Fixation stability is encouraged by dynamically changing the fixation mark. This serves several additional purposes, viz, to cue in presentations, synchronize blinks, minimize after-images, and relax accommodation. Additional ergonomic features are auditory and visual feedback and a continuous adaptation to the subject's current reaction time.

The Rabbit Test can test also the flanking regions (between 30 and 60 degrees of horizontal eccentricity) and the fovea (-4 to +4 degrees), using the same rarebit test principle (see further).

2. Equipment

Rarebit Perimetry runs under Microsoft Windows 95/98/NT/2000/XP. Special demands apply to the graphics hardware: a high-quality, stand-alone, thin-film transistor (TFT), liquid crystal display (LCD), with a native resolution of at least 1024 x 768 picture elements. A native resolution of 1280 x 1024 pixels (or better) plus a digital interface provide maximum precision. A matte black front panel is preferable. Any front panel indicator lights and glossy emblems need to be covered, e.g., with matte black sticky tape.

LCD manufacturing tolerances often allow a few pixel flaws but defective pixels are unacceptable for the Rabbit Test: the test requires full control over each single pixel. Use the test button on the test's Calibrate Panel to check that all pixels actually are turned off when the screen is set all black and that all pixels actually are turned on when the screen is set all white.

Note that the imaging characteristics of the most common variety of visual display units, the cathode ray tube (CRT), are inappropriate for Rarebit Perimetry. Hence, a conventional monitor **MUST NOT BE USED**.

The most common LCD size is 15", which will be assumed in the following. Larger screens can also be used but the software will use the central 15" only. Standard viewing distance is 0.5 meter, which ensures that the angular subtense of pixels is small enough for the test task. At this distance, the screen occupies about 30 degrees of visual angle horizontally. To double the visual field coverage, the Rabbit Test displaces the fixation mark in a preset sequence.

The four central-most test locations need a 1.0 meter test distance to meet the angular size requirements.

0.5 m viewing distance requires a near addition of + 2.0 diopters and 1 m requires + 1.0 D. Any astigmatism should be corrected as the spherical equivalent. Meniscus-type lenses are preferred. Personal reading glasses can

be used if the lens diameters are large enough to prevent vignetting. Bifocal, trifocal and progressive spectacle lenses are not suitable.

Set up the test in a dark, secluded area. Take pains to suppress any potentially disturbing light reflexes. Also, take pains to arrange for a good seating: a comfortably seated subject will sit still enough to dispense with a headrest.

A simple way to set up the hardware is to place the LCD on a sturdy, wall-mounted shelf, at eye level. Obtain two lengths of telescoping square aluminum tubing, approximately 25 x 25 x 700 mm, and 27 x 27 x 1000 mm. Bolt the shorter piece of tubing to the under surface of the shelf, to support a lens holder at 500 mm distance from the LCD front surface. For the paracentral part of the test, remove the lens holder, slide the longer piece of tubing onto the shorter one, all the way towards the shelf, and fix the lens holder at 1000 mm distance from the LCD.

Alternative suggestions are to use a commercial, wall-mounted, adjustable monitor carrier and a head-borne correction lens holder. Such arrangements provide greater flexibility and allow examination of subjects confined to wheelchairs or beds.

The test is planned to be run from the keyboard: the mouse should be used as the subject's response button. It is most practical to use a cordless optical mouse, placed in the subject's lap.

Background software processing should be avoided to prevent timing disturbances.

Rarebit Perimetry can be uninstalled from Window's Control Panel. Any stored results will remain in place.

3. Calibration

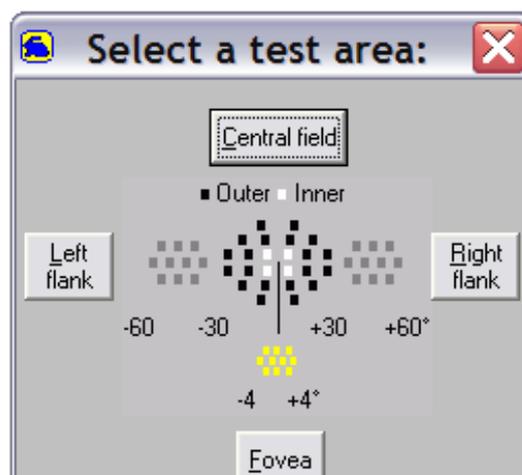
The size of the display needs to be set before running the first test. Select Arena, then any Field Area, then Calibrate. Measure the horizontal distance between the two arrowheads, in millimeters. Enter the result in the Display Width textbox, and tap the Enter key. The calibration procedure needs to be repeated if the display is exchanged for another model.

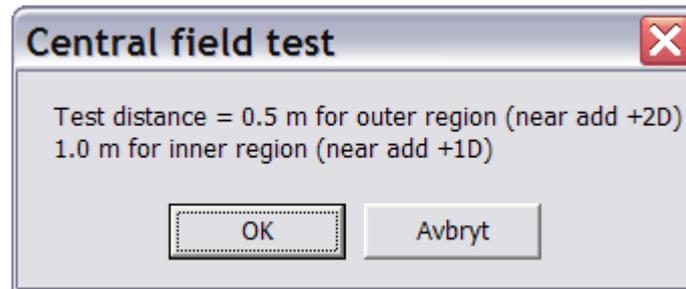
Target and background luminances should approximate those used in conventional acuity testing, i e, about 150 and 1 cd/sqm, respectively. Monitor default settings are often adequate. The Calibrate display provides panels suitable for luminance measurements. Room illumination should be turned off. Test conditions should be kept constant between examinations. Luminance adaptation is not required because of the photopic level of the fixation mark and the test targets.

Target exposure time is set to 200 milliseconds, which constitutes a compromise between the LCD's restricted temporal bandwidth and the desire to minimize effects of sweeping eye movements. Exposure time can be altered in the Calibrate display. Minimum target size can also be altered. Alterations are not recommended, however.

4. Running Rarebit Perimetry

Click on the opening panel's Arena button and select a test area (central field, flank, or fovea). A "radio button" panel then appears in the screen's lower right corner. Labels hint at the buttons' functions. Some buttons are sometimes disabled, as shown by faint labeling.

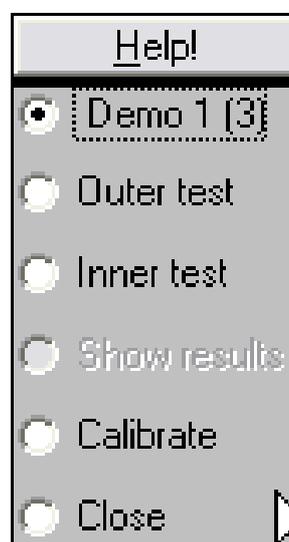




To keep distractions at a minimum, the button panel will be hidden during testing. The same applies to the mouse pointer.

Three keyboard keys serve most operations: Plus, Minus, and Enter. It is most practical to use the keys furthest to the right on the keyboard. Tap Plus or Minus to move the focus (the dotted rectangle) among the available options. Press Enter to confirm a selection. Whenever a dynamic presentation is selected, the Plus and Minus keys serve to start and stop, respectively.

A brief Help Text can be displayed during the test's demonstration phase. Tap the Help! button to display the text and tap the DEL key to hide it.



It is appropriate to begin with a demonstration of the test principles. Select Demo 1(3) to show examples of dot patterns in the screen's center. A random generator produces either a horizontal or a vertical pair of dots, a single dot, or nothing at all. Dot size is now fairly large and will decrease progressively in later phases.

Select Demo 2(3) (by tapping the Enter key) to add a dynamic fixation mark, to vary target positions on the screen, and to respond to mouse button clicks. Explain the required responses: one click for one dot, two for two, and none for none. Hand the mouse to the subject and show how to click and double-click its left button.

There is a liberal proportion of control presentations (4 out of 10), i.e., blanks and single dots. A response to a blank presentation or a double-click response to a single dot presentation causes the brief appearance of a red "traffic light" at the fixation mark, plus an annoying sound. Correct responses are rewarded by a green traffic light and a soft pinging sound.

Finally, select Demo 3(3) and tap the Plus key to run a dynamic display similar to that used in the actual test, including a moving fixation mark. Tap the Minus key to return to the selection panel. The demonstration display can be stopped and restarted any number of times.

Let the demonstration run until it is clear that the subject masters the procedure: look at the fixation target all the time and respond when and only when one or two dots are seen.

The brief target exposure time may induce a sense of urgency to respond. This should be counteracted by explanation. There is actually plenty of time to respond following each presentation. The test's continuous adaptation to current reaction time should allow everyone to find a comfortable pace.

Start a real test by selecting either the button labeled Outer Test or the button labeled Inner Test. Then tap the Plus key. The test looks much the same as the dynamic demonstration. The proportion of blanks and single-dot presentations is now reduced to 1 in 10.

If Outer Test has been selected, the test will traverse the 20 outer test locations repeatedly until it is stopped by the examiner, or until 15 passes have been made. The number of passes made is shown by a faint blue digit in the top right corner of the screen. Similarly, if Inner Test was selected, the test traverses the 4 inner test locations repeatedly.

There are two ways to stop the test. One is to tap the Minus Key: this aborts the test immediately and discards any results obtained during the current pass. The other way to stop is to tap the P (for pause) key: this makes the test stop when the current pass is finished. Once the test has been stopped, running statistics and test results can be displayed by selecting View Results.

Another way to run the test is to move the selection point to Outer Test or Inner Test and then, instead of tapping the Enter key, tap a digit key between 1 and 5. The test will then run the selected number of passes. The run can be

aborted at any time by tapping the Minus or the P key, as described in the preceding paragraph.

The test can be stopped and re-started any number of times, up to a maximum of 15 completed passes.

A single test pass allows only a crude categorization of levels of function within each test location, i e, two, one, or none dots seen, or 100, 50, and 0 per cent functional neural channels. Although such a categorization sometimes suffices, a finer gradation is usually desired. This requires additional traversals. Five passes may strike a good compromise for many situations. More than five passes should be made if detection of low-degree damage is at premium.

Select Show Results to plot available results. The display then shows the number of dots seen at each test location as a percentage of the number shown. A table of raw results is also provided. In the table, -1 means "not tested".

Once a suitable number of passes have been made for the outer test locations, the four inner ones should be tested (or vice versa). Change the test distance and the correcting lens and start testing as described above. It is generally best to run the inner test the same number of passes as were used in the outer test.

Switches between inner and outer tests can be made any number of times.

Note that the test dots will appear smaller at the 1 m test distance and may be more susceptible to any optical faults. Some patients with cloudy optical media may need to use a 0.5 m test distance also for the central-most test locations. Alternatively, this part of the test can be skipped, if so desired. Note that running the inner part of the test at 0.5 m test distance incurs a risk of underrating any damage.

Select the Save button to save results. This opens a panel where the subject's personal data and the examiner's notes should be entered before results are saved to disk. The record number should be entered into the subject's file to aid later retrievals.

The saved file includes summary data only. All the raw data is temporarily placed on Window's Clipboard in the Save phase and can be reviewed, printed, or stored using a text editor, e g, Window's Notepad. Use the editor's Paste function to retrieve the raw data from the Clipboard.

O p t i o n s

The radio button panel can be flipped to the screen's left side if this is more convenient: hold down the Ctrl key and tap the Left or Right Arrow key to produce a flip.

The size of the fixation mark can be altered by holding down the Ctrl key and tapping the Plus or Minus keys.

The standard fixation mark can be replaced by one that mimics a jumping rabbit. It is primarily intended for work with children. To replace the standard fixation mark, rename the file PDF.BMP to oldPDF.BMP, and the file KidPDF.BMP to PDF.BMP. Use the opposite procedure to restore the standard fixation mark.

All keyboard procedures were optimized for stand-alone keyboards. An efficient alternative is to use a dual mouse setup. Most PCs can use two mice, one for the subject and one for the examiner. In such a setting it is practical to disable all mouse buttons but the left one in the subject's mouse: this prevents the subject from accidentally taking control over testing. Instructions for disabling mouse buttons are usually provided in the mouse setup software.

In a dual mouse system, the examiner can make selections using his or her mouse. LEFT-click on any desired selection point and RIGHT-click to confirm. Dynamic presentations can be stopped and started by RIGHT-clicking anywhere on the screen (left-clicking on the screen is reserved for the subject's responses).

If the subject is not comfortable with a mouse, he or she can use the keyboard Ctrl key to respond. Tap the Ctrl key once if a single dot is seen, twice if a pair is seen.

Users of laptop computers may find it useful to note the following alternatives to the Plus and Minus keys:

- Move among selections using the Up and Down Arrow keys.
- Start and stop dynamic presentations using the Enter and Esc keys, respectively.
- Consider using a separate numeric keyboard.

The Rabbit Test can be run in an intranet setting with a central storage of results. To activate central storage, open Notepad and type the full path to the storage area, e g,

G:\CommonFiles\RabbitWarren\

Note the terminal backslash. Save the file under the name RTPath.txt. To stop using central storage, delete the file RTPath.txt, and move the RTResult.txt file to the local Rabbit directory.

5. The Fovea and Flank Tests

These tests use the same test principles as the regular Rabbit Test so a detailed presentation does not seem necessary. Both depend on a matrix comprising 10 square test areas. Both tests cue in presentations by sound.

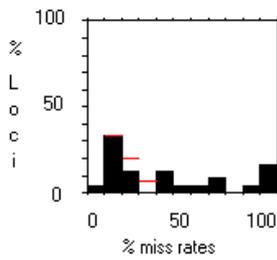
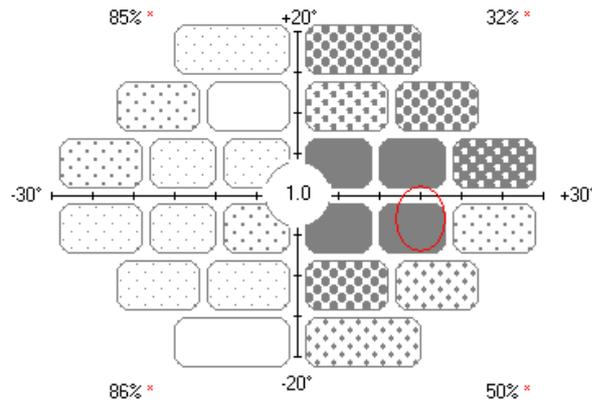
The Fovea Test uses a small, stationary fixation target. Subjects who have difficulties seeing the fixation mark should be asked to simply look at the center of the screen. Use of a larger fixation mark may interfere with the central-most test target presentations. The recommended test distance is 2.0 m, corresponding to a near addition of +0.5 D. At this distance, the square test areas subtend 1.5×1.5 degrees and the test dots are separated by 1 degree in each pair.

The Flank Test depends on a user-provided external fixation mark, to be placed 0.5 m to the right or left of the screen's center, depending on which flank is to be tested. Test distance is 0.5 m. Correcting lenses are selected in the same way as in the regular Rabbit Test and should remain oriented in parallel to the screen's surface. The rectangular test areas subtend 6×6 degrees.

Results from the Fovea and Flank Tests are stored in the same way as those of the regular test and use the same viewing function.

6. Viewing stored results

To see a stored record, click on the opening panel's Museum button. The latest record will then be shown. If another record is desired, type its number in the Number Box and press Enter.



Mean Hit Rate: 64 ± 6.0 % *
 27 Hit Rates < 90: 62 ± 6.1 % *
 Area < 90: 87 %

12	50				
25	6	44	50		
25	12	12	100	100	62
12	12	25	100	100	25
12	18	50	38		
6	38				

% miss rates

Record number
 820 1280*1024
 A- M A-M DOB 20/11/1933 Age 69 RIGHT eye Acuity: 1.0 Correction: -5/-6
 Dx: op hypad Date of exam: 17/03/2003 Performance: + Tests: 137/4 Errors: 0
 Test time: 5:13 MRT: 0.72 Examiner: Ver. 3

It is possible to search all records for any specific information. Click the Find button to learn about the alternatives.

Find a -

Name
 Date of birth
 Diagnosis
 Comment

Year Month Day
 1933 11 20

#	No.	Name	DOB	DOX	Age	Diagnosis	Comment	Side
1	574 A	A-M	20/11/1933	26/03/2001	67	op hypad		R
2	820 A	A-M	20/11/1933	17/03/2003	69	op hypad		R

Records can be browsed sequentially by clicking on the Up and Down Browse buttons to the right of the Number Box. Browsing can be limited to a user-defined list, e.g., a list of all examinations done on one and the same eye. Use Find to collect all the subject's examinations. Then, move the highlight to each record to be included in the list, tap Enter once for each choice, terminate with

Enter, and browse the list. The listed records can be printed in an overview format with 6 records per page, by tapping the Print Overview button.

Records are stored sequentially in the ASCII, comma-delimited format, in the file RTRResult.txt. This file can be read by most word processors, spreadsheets, and database managers. The file named RTRResultHeader.txt can be used to label the various fields within each record.

If reference needs to be made to test location numbers and coordinates, use the Clipboard function described in Section 4 to obtain a list. RTRResult.txt stores test results serially according to location number, expressed as per cent dots missed (-1 if not tested).

Record numbers are incremented sequentially, starting with number 1. If another starting number is desired, open the file RTRResult.txt with Windows' Notepad editor, and change the numbers of each and every record already stored to fit in the desired sequence. The record number is contained in the first column. Make sure that the new numbers form an unbroken sequence: any gaps or duplicates will cause problems when retrieving records. Any editing of RTRResult.txt must be extremely careful. Any losses (or additions) of separators (comma and quote signs) will cause problems when retrieving records. It is prudent to store a copy of the original file in a different folder before beginning editing.

Print-outs are topped by a one-line header stored in a text file named RTLabel.txt. It can be edited using Windows' Notepad editor.

In presentation settings it is sometimes useful to flip record laterality. Click on the rabbit icon to flip the image. Flipping does not affect the stored records.

7. Interpretation of results

Most results are presented in a per cent seen format. 100 per cent is normal and is in the field map represented as an open rectangle. The proportion of any missed presentations is represented by various degrees of shading: the darker the shading, the larger the proportion of missed presentations. The proportion of missed presentations is also given numerically in the mini map below to the right. The left mini diagram summarizes the statistical distribution of results.

The Mean Hit Rate index averages results across the field map, excluding the location nearest to the blind spot. Normally, the index (and the quadrant averages) should come close to 100 per cent. Similarly, standard deviations should come close to 0. Interpretation should be sensible: nobody is perfect. Results are also averaged separately across locations where more than 10 per

cent of dot presentations were missed. This provides an index of average level of function within depressed field areas.

Numerical results are compared to preliminary normal limits (which are stored in the file RTRef.TXT). Results falling outside limits are marked with an asterisk.

A zero result means that no dots were seen. This is not necessarily the same as complete blindness: stronger stimuli, e g, the examiner's hand, might still be discernible.

One test location partially overlaps the expected position of the blind spot (shown by a red oval outline). A near normal result here does not necessarily indicate poor fixation. Recall that dots are distributed at random inside the rectangular test area. It may well happen that test dots will fall outside the blind spot border and therefore may be seen. Further, blind spot position and size varies between subjects. Blind spot testing has little, if any, diagnostic interest.

The spatial distribution of abnormal locations defines the nature of any field defect, e g, an arcuate scotoma or an upper temporal depression. Topical diagnosis follows the same rules as in ordinary perimetry.

The Error statistic sums responses to control presentations. It should come close to 0. Trigger-happy subjects will produce a larger number of errors.

Other statistics include a count of the number of presentations and passes, total test time, and the mean reaction time (MRT).

8. Concluding remarks

A normal eye hosts more than one million retino-cortical neural channels. About one-half of these are contained inside 30 degrees of eccentricity. The sheer number of channels and the limited endurance of real subjects combine to prevent exhaustive probing. The optimum compromise needs to counterbalance the minimum amount of information required for a sound clinical decision and the maximum meaningful test time. Both factors are extremely difficult to quantify and both may vary from time to time, also for one and the same subject. Rarebit Perimetry provides a unique solution in that testing time (or more precisely, the number of passes) can be adapted to current needs and capabilities. The time of one pass (less than one minute) is short enough to maintain most subjects' attention. Flapping attention is presumably an important source of variation in Rarebit Perimetry. The threshold approach of conventional perimetry involves numerous additional sources of variation.

An important aspect of test quality relates to the smallest degrees of damage that can be detected. This depends in part on how well limits of normal performance are known. Limits of normal are particularly simple to define in Rarebit Perimetry: normal eyes need exactly 2 bits of information to recognize a pair, no more and no less.

Assessment of degrees of damage is a bit more involved – this is where statistics comes into play. Consider a subject who has lost 10 per cent of his or her retino-cortical neural channels. This subject actually has a reasonable chance to see 2 out of 2 dots: the probability equals 0.9×0.9 , or 0.81. At 20 per cent loss, probability equals $0.8 \times 0.8 = 0.64$, at 30 per cent 0.49, and so on. Similar calculations can be made for the probabilities to see only one dot or none. Rarebit Perimetry estimates damage from the observed proportions of responses. The better these proportions are defined, the better the estimate of damage. The larger the number of test passes, the better the estimate. In principle, there is no lower limit on detectable damage. Results from multiple examinations can be combined for maximum efficiency. It is interesting to note that conventional perimetry is held to require about 25 – 50 per cent loss for consistent abnormality.

With a limited number of target presentations, as required in a clinical test, the outcome of a single sitting may occasionally deviate dramatically from average outcomes. It is prudent to avoid attaching too much weight to results in single test locations. Instead, results are best assessed for groups of neighboring locations. The quadrant summary scores may provide helpful leads.

The use of spatially extended pairs of dots naturally works against delimitation of field defects of small angular subtense. Conventional perimetry is not necessarily better in this regard as it usually spaces test locations by several degrees of angle.

No claim is made that the simple neural channel model presented here is exactly true: it is proposed as a starting point for future developments.

Although the format of Rarebit Perimetry is most unusual it is hoped that it will soon come quite natural, also to the layman. And natural perimetry was the goal of the Rabbit project.

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Reference: Frisen, L: New, sensitive window on abnormal spatial vision: rarebit probing. Vision Research 42: 1931-1939, 2002.

Differences between software versions 3 and 4 concern mainly the replacement of circular test areas of fixed size (5 degrees) with rectangular test areas of different sizes, and a reduction of the number of test locations, from 30 to 24. These changes were motivated by a desire for a better field coverage and a better Gestalt of visual field defects. The shorter examination time was an extra bonus.

Version 4 software can read version 3 results, which will be displayed in the new version 4 format. Version 3 software cannot render version 4 results. Normal limits remain unchanged. To keep old and new results together, copy version 3 RTResult.txt to the new version 4 directory.