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Kognitive Therapie und Hirnleistungstraining

Screening: Campimetry

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1 Disorders of the visual field

Basic information on the data analysis of screening results is available in the RehaCom manual, Chapter "Screening and Diagnostics".

Impairments of vision, visual-spatial perception, and attention are common results of brain injuries. According to Zihl (2006), 20–40% of patients with an acquired brain injury have visual problems, 61.7% of those patients have restrictions or losses in the visual field.

The ability to see is a very important sensory function. Disorders affecting the visual field impact orientation and, depending on the degree of disturbance, have an effect on everyday actions (e.g. searching and finding objects when eating or getting dressed, safely navigating a room without bumping into something, recognizing faces, reading the newspaper, watching TV, using the computer). Visual field is vitally important, especially when driving a motor vehicle. Disorders of the field of view and visual field affect participation in many aspects of life according to ICF and therefore require therapy and rehabilitation to improve the participation.

Body-Head-Eye system

A persons entire body is actively involved in the visual orientation and visual cognition, including the orientation and position of the body, the head, and the eyes in space; the performance capability of the eyes (e.g. visual acuity or agility), and eventually the central information processing of all involved sensomotoric processes in the brain. Our normal behavior is that we constantly move our body or very rarely remain motionless. We constantly explore objects and our surrounding world with countless eye movements geared to our current goal of action, or briefly turn to peripheral new stimuli and assess them. The field of vision solely by eye movements (without moving one’s head) is thereby smaller (about 50° one-sided) than the peripheral visual field in central fixation (about 90° one-sided). The combination of the field of vision and the visual field extends the visual range up to 115° (one-sided). The field of vision can be shifted sideways even further by head and body movements.

Fig. 1: Full visual field of both eyes

Shape recognition is quite possible in the central field of vision (about 5° on one side unilateral) with fixation; in the peripheral visual field without fixation, even color perception (see fig. 1) and especially motion perception are possible. In order to reliably recognize and differentiate shapes and patterns, focusing on the stimulus visually (fixation) is necessary.

Figure 2 shows the qualitative visual field limits in the normal left visual field.

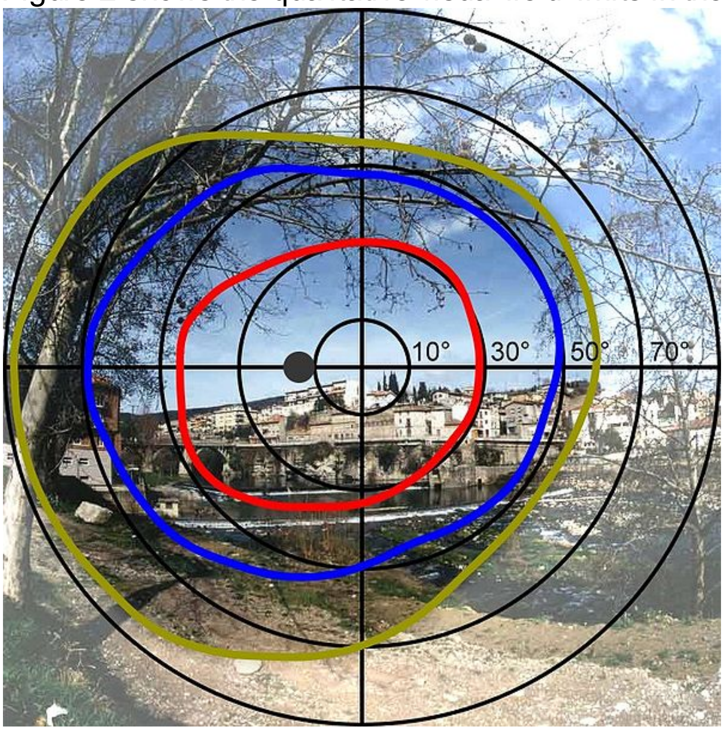

Fig. 2: qualitative visual field limits in the normal left visual field

Fig. 2 shows a polar diagram of visual field of the left eye [Wikipedia].
red and blue circles: sensitive area for colors;
yellow circle: entire visual field; black spot: blind spot

Consideration of further cognitive performances

The ability to see is an integral part of our interactions with the world around us. Because the ability to see is so important, further cognitive performances, especially attention, are always involved.
When testing a patient's visual field after an acquired brain injury, you should also take into account other performance functions, such as attention and concentration, memory and executive functions. The interpretation of results depends on many factors, particularly in the early phase after a brain injury (1-4 months), where a characteristic instability for many functions will be found.
You should make sure to have pauses during the implementation of therapy. Also ensure the comprehension of the instructions by repetition (in case of memory losses) (Zihl & von Cramon, 1985).

Triad of the limitations of the visual field

In disorders of the visual field and the visual perception, there are three limitations (Zihl & von Cramon, 1985) for which we may collect measurements:

- limitations of the visual field that affect stimulus detection at a central fixation (visual field limitation)
- limitations of spontaneous amplitudes and systematics of eye movements in the affected visual field (narrowing of the field of vision)
- limitations of spontaneous exploratory searching and noticing of stimuli (spatial attention restriction)

Limitations of the visual field and saccadic movements / gaze strategies can occur, especially in a patient with homonymous hemianopsia without disorders of the attention field.

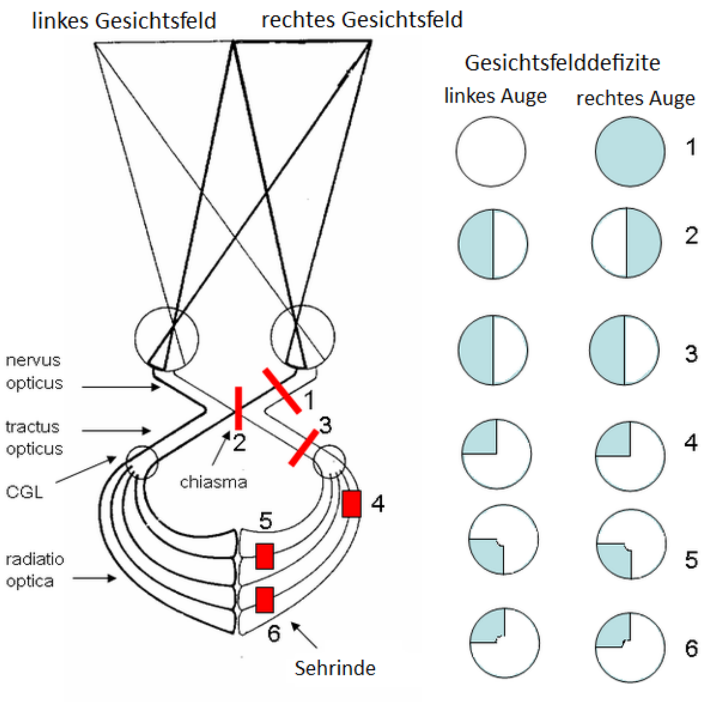

Fig. 3: Visual field deficits depending on the location of the lesion

- 3) homonymous hemianopsia (right or left): In both eyes, the same side is affected by loss (patients see only the left or right side of an image section - occurs frequently)
- 2) heteronymous (binasal oder bitemporal) hemianopsia: On both eyes the opposite side is affected by loss (patients suffer from “tunnel vision” - occurs rarely)
- 4 - 6) Quadrantanopsia is characterized by the loss of a quarter of the visual field. Like the hemianopsia the quadrantanopsia is mostly homonymous, both eyes are affected by the loss in the same quadrant.

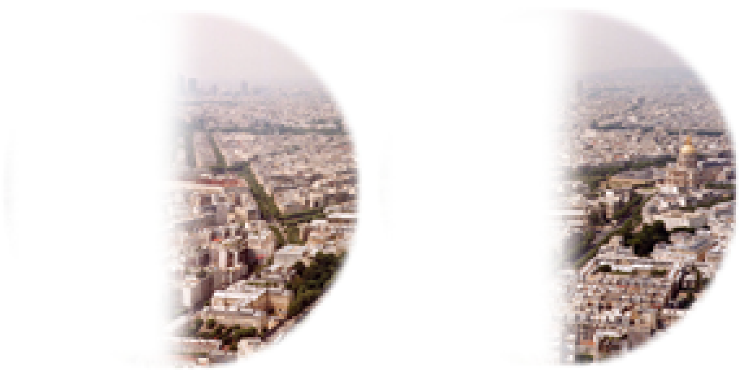

Fig. 4 : Restricted visual field in hemianopsia to the left

Disorders of the visual-spatial attention (neglect)

In case of severe neglect, the three limitations must be considered. Neglect phenomena can be assumed if spontaneous orientation, stimulus discovery, and exploration by saccades are disturbed. The patient might not detect people, items, or test stimuli in the affected part of the visual field (Heilmann, 1979; Karnath, 2003).

Fig. 5: Restricted field of perception in neglect to the left

In patients with neglect, indicators for neglect can often be found in other sensory modalities, such as extinction at double simultaneous stimulation, visual-spatial disorders, and improvements in performance on conscious attention allocation. Patients with hemianopsia without neglect can't improve visual field deficits by conscious attention allocation (Kerkhoff, 2004).
Therefore, a competent differential diagnosis is important, especially as lesions are not uncommon where hemianopic vision deficits and neglect phenomena can be found in the acute phase and can only be differentiated in the chronic phase (> 3 months after lesion).
Through spontaneous remissions in the acute phase, neglect disorders can almost halve to about persistent 33% of patients with right hemispheric lesions and approximately 13% of patients with left hemispheric lesions (Stone et.al., 1991, as cited by Kerkhoff, 2004). In the clinical practice, it is not uncommon for patients to show a quadrantanopsia that was previously hidden by the neglect.
In the event that you suspect a patient having a disorder combined with neglect and hemianopsia/quadrantanopsia, both defects should be treated.

1.1 PC-supported detection of visual field deficits

The ophthalmologists use perimetry to measure the visual field by varying either position or intensity of a stimulus (e.g. Goldmann perimeter or Tübinger perimeter). Under standardized stimulus conditions, the ophthalmologist can examine both the expansion of the general visual field (stimulus detection) and, if required, the limitations for the light sensitivity, color, and shape recognition accurately.

In the neurological clinic, rehab clinic, or outpatient neuropsychological practice, cost-intensive perimetry is (usually) not available. It is therefore necessary to resort to simple testing, using paper-pencil methods and PC-based visual field screenings. However, this diagnostic instrument allows an imaging of visual field deficits, neglect symptoms and reading disorders that is sufficiently precise for therapeutic indications.

In the PC-supported measurement of the visual field, which is used as a screening, limitations towards a perimeter are existing in the methods that were available up to now:

- as a result of the limitation of the monitor, the covered visual angle area is much smaller
- the programs do not allow an evaluation of the contrast sensitivity, color or shape perception
- the fixation constancy can not be observed in confrontation

By the use of modern flatscreen monitors (24" or 27") or TV (32" or 34"), PC-supported coverages are already able to capture a binocular visual field up to 30°. When using a projector with a rear projection screen, the coverage can be expanded up to 60° (that corresponds to the required visual field for the driving ability).

Central and peripheral task

In the perimetry, the fixation constancy is controlled by a person who observes the patient from the front and reacts accordingly when leaving the fixation. This possibility is missing when measuring the visual field on the PC. Besides the frequency of measured points, the fixation constancy as a critical indicator of a precise measurement is of particular importance.
To control the fixation constancy, a central task was therefore introduced into PC visual field tests, which can only be solved by visual focusing. In parallel, the actual measurement of the perception of stimuli in the visual field was defined as a peripheral task. This created a dual task design with requirements on increased attentional performances. In addition to the sustained attention, the selective and divided attention performances mainly belong to it.
For example, the original version of a common PC visual field testing consists of a visual-verbal central task (recognize letters and name them verbally) and a visual discovery task of peripheral kind (notice flicker stimuli and press the button). The transition between the central and the peripheral task requires adaption ability and sequencing (verbal naming, nonverbal keystokes). The stimuli are presented for a maximum of 3000 ms. The presentation time is also the maximum reaction time. The peripheral stimulus is displayed over a "longer" period (max. 3000 ms) and can cause an automatic orienting response, an eye movement up to the Flicker stimulus. The shortest trial version runs for about five minutes, the longer version more than ten minutes without pause.
In the new variant, the central task has been replaced by a nonverbal visual discrimination task with requirements on selective attention (answer 4 target stimuli out of 8 stimuli). The response reaction in the central task is nonverbal in the form of

a keystroke and has been aligned to the output of the peripheral task. The presentation time of the central stimuli is 400 ms. The presentation time of the peripheral stimuli is 3000 ms. The test duration is five minutes without a pause. Another newer screening design for driving ability diagnostics combines the measurement of the visual field with distractor stimuli, which are used in neglect examinations. The screen is filled with grey dots. One dot at a time can flash up brightly (peripheral task). The presentation time for peripheral stimuli was shortened to 800 ms. The central task again consists of a nonverbal visual discrimination task with requirements on selective attention (answer 4 target stimuli out of 8 stimuli). It has to be reacted to both tasks non-verbally with a keystroke. The number of central stimuli and thus the requirements on the visual focusing was significantly increased (ratio stimuli central / peripheral: 470/85).

Requirements on selective and divided attention

Attentional processes and requirements for greater attention performance outside the spatial attention are involved in all previous designs for PC-based visual field tests and may affect the actual intended visual stimulus perception and response action in disorders of attention performance.
To reduce the impact of attention deficits, the discrimination tasks should be as simple as possible (selective attention).
The central and peripheral task should be of the type and modality as similar as possible in dual-task design to keep the demands on the shared attention low.
To relieve the focused attention and sustained attention, pauses during the implementation should be made possible.
Visual field tests enable conclusions about the patient's performance and a probability indication of the available field of view, but they are not a direct measurement of the underlying cerebral failure or neuronal damage.
Directly observable and computerizedly measurable are only behavioral responses to the stimuli of the task. An omission or incorrect reaction may also have other causes than immediate vision loss. The interpretation of the overall result therefore requires professional expertise.
Other situational conditions such as daytime and lighting conditions, psychological state or medication can have an effect on the result. Therefore, care should be taken to standardize the examination situation (e.g. darkened room).

2 Field of application

Basic information about the screening can be found in the RehaCom manual, Kapitel "Screening und Diagnostik".

The "Campimetry" screening is a grid test to monitor and evaluate computer supported training. It includes the modules saccade training, exploration training, and restitutive field of vision training. At the first screening the limitations of the field of vision are measured and the severity is determined. The results of all examinations, e.g. the neglect examination, should always be considered when evaluating the field of vision.

Target Patients

The screening is suitable in case of suspected neurological vision defects, e.g. hemianopsia or quadrantanopia. The goal is to examine the field of vision for defects through static stimuli with fixation control, and to determine the where training is needed as well as the areas in which there is potential for restitution.

For clients who suffer from additional cognitive deficits such as attention- and concetration disorders or a slowed down perception and motor skills, another screening with different settings or adjusted parameters can be done. The same is true for vision defects such as cataract or disordered sensitivity for coulour and contrast. Children whose speech and understanding of language and words is limited can usually do the screening without any problems.

3 Test description

In the campimetry screening, the field of vision can be examined binocularly or monocularly. Unlike the three-dimensional perimetry, campimetry is two-dimensional. The client's task is to react to stimuli within his field of vision under fixation control.

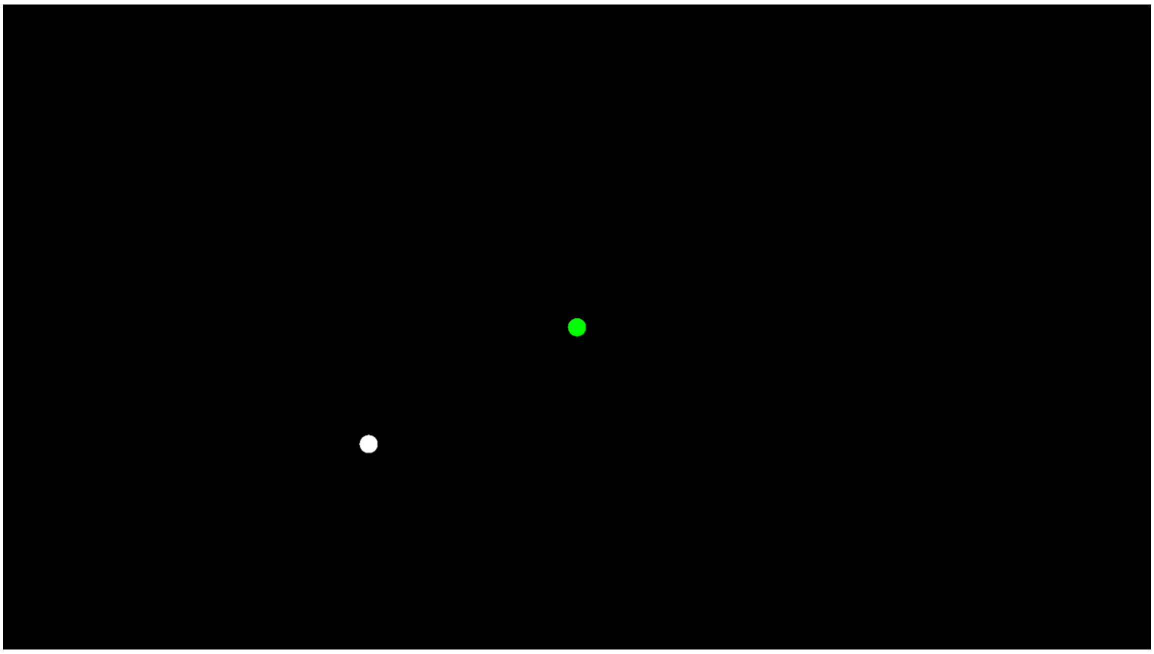

Fig. 6: Campimetry screening w ith central fixation point and stimulus in the periphery.

Before beginning a screening parameters need to be adjusted, such as the size of the monitor, the distance between the monitor and the eyes, the size of the matrix, and the client's eyes. The client should be positioned in front of the monitor in a set distance, comfortable but fixed. To easily achieve this you can use the chin support, which is available additionally.

During the screening the client's gaze should stay fixed on a point on the screen. To ensure this the client has to react to the point changing in shape and colour in irregular intervals.

In the test, stimuli appear in random intervals and on random places on the screen. Position and number of stimuli are calculated based on the parameters set in the beginning. Every stimulus and change of colour should be acknowledged as fast as possible by pushing the "answer" key.

3.1 Settings

To conduct a campimetry screening it is necessary to enter several parameters. They are asked for before beginning the screening.

In the parameter menu the program will ask you for settings such as screen height- and width, distance patient to screen, size of matrix, and eye to check. Without them, no usable results are attainable.

Please note: Only tests which use the same parameters can be compared. Tests with differently sized matrices, e.g. 24x16 and 18x12, cannot be shown layered over each other. If screen height, -width, and/or distance are different layering is not possible.

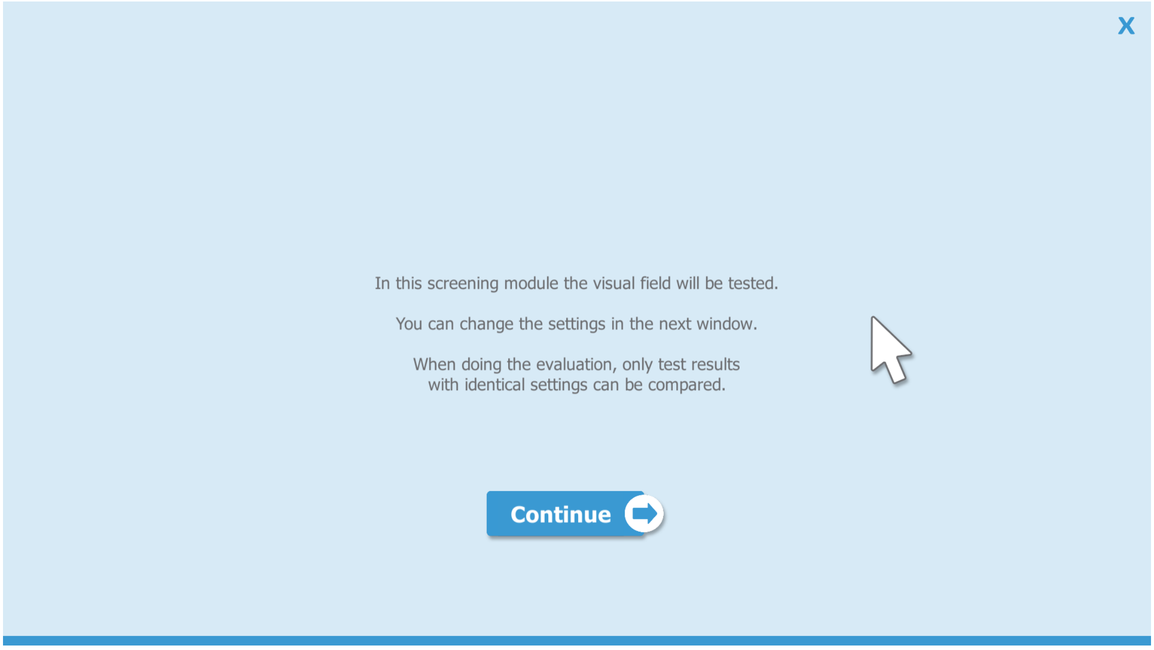

Fig.7: Advice to entering parameters and comparability of results.

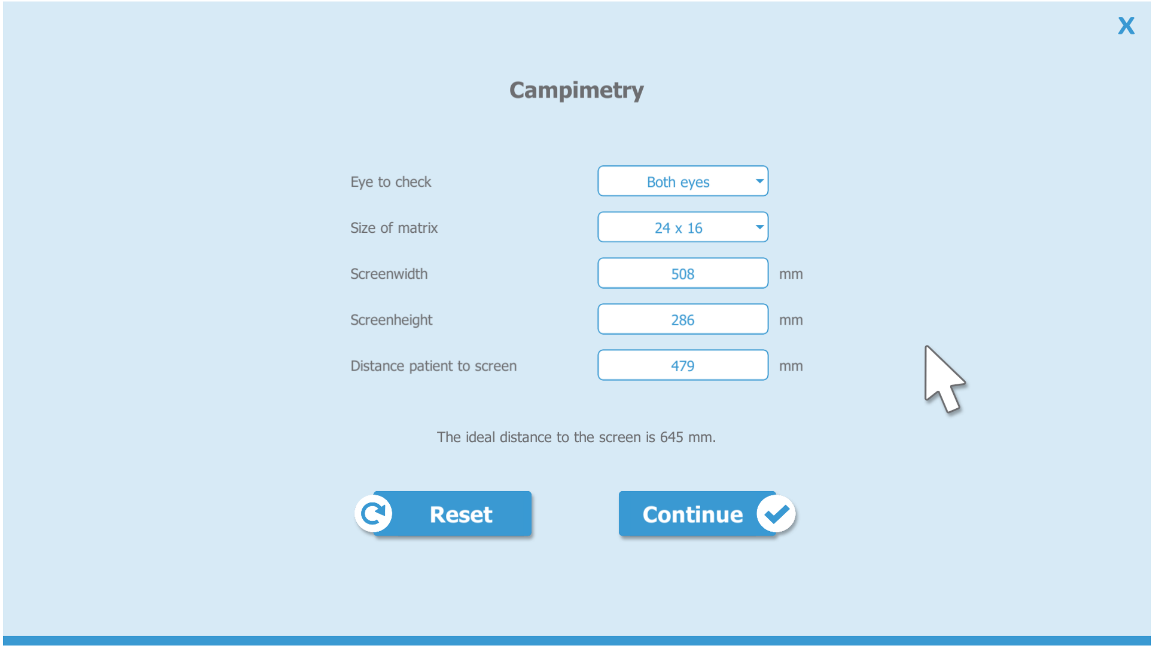

Fig.8: The parameter menu with boxes to enter required parameters.

Parameters of campimetry:

Eye to check
Please choose which of the client's eyes should be tested:

- Both eyes
- Left eye
- Right eye

Size of matrix
Choose a grid in which the field of vision should be measured. The following options are available depending on your selection in the parameter "eye to check":

- Both eyes:
  - 24 x 16 (404 stimuli*)
  - 18 x 12 (236 stimuli*)
  - 12 x 8 (100 stimuli*)
- Left or right eye:
  - 16 x 16 (276 stimuli*)
  - 12 x 12 (160 stimuli*)
  - 8 x 8 (68 stimuli*)

Screenwidth
Enter the width of the entire used part of the monitor.

Screenheight
Enter the height of the entire used part of the monitor.

Distance patient to screen
Enter the distance of the client's eyes to the screen after placing your client in front of the centre of the screen.

** stimuli to check the field of vision, fixation controls excluded.*

In addition, the optimal distance between the client and the screen is shown below the parameter boxes.

The parameters are only saved after clicking "continue". If you click "reset", all changes will be discarded and the client's last parameters/ the default parameters will be restored.

3.2 Testing process

Procedure

1. Entering parameters

Before conducting the test the required Settings need to be adjusted.

2. Instruction and Testing

The test begins with a short practice run. The different symbols are introduced and the procedure is explained. After that the practice run takes place and can be repeated if needed.

The test uses 3 different symbols. It is the client's task to react to the stimuli as fast as possible by pressing the OK-button.

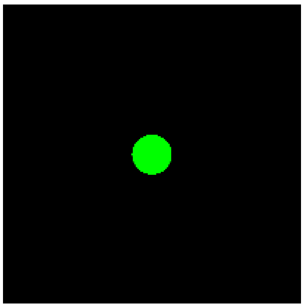

Abb. 9: Fixationspunkt

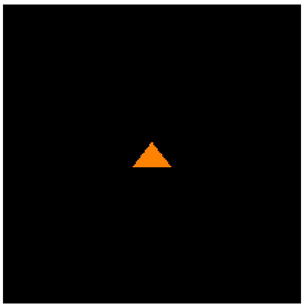

Abb.10: Fixationskontrollpunkt

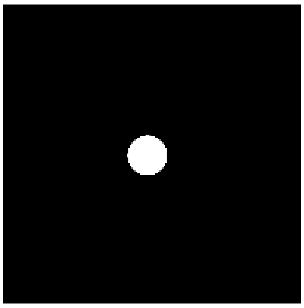

Abb.11: Stimulusreiz

The fixation point is in the centre of the screen and will occasionally change its shape/colour. This is necessary in order to fix the gaze and to ensure the field of vision stays statically examinable. If there is a reaction to a change of colour/shape within the designated time window of 1000 ms, a feedback sound plays.

The stimulus appears anywhere on the screen. It appears in a random order. When a stimulus is seen, the OK-button should be pressed as fast as possible. If there is a reaction within the designated time window, a feedback sound plays.

3. Conducting the test

After the practice run the test takes place.

Every stimulus (or fixation control) appears after a random amount of time. Total number and position of the stimuli are calculated based on the parameters. After 500 to 1000 ms have passed, the stimulus is shown for a short amount of time and then hidden again. Afterwards, the client has 1000 ms to react to the stimulus.

The positions around the point of fixation are checked multiple times, depending on the size of matrix selected.The following images show how often every positon in a matrix is checked.

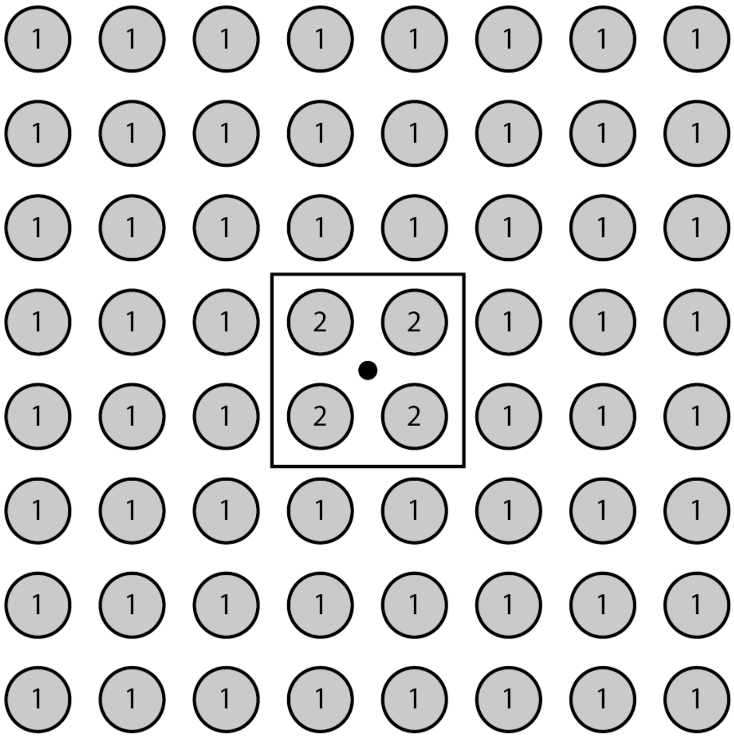

Fig. 12 Matrix 8x8

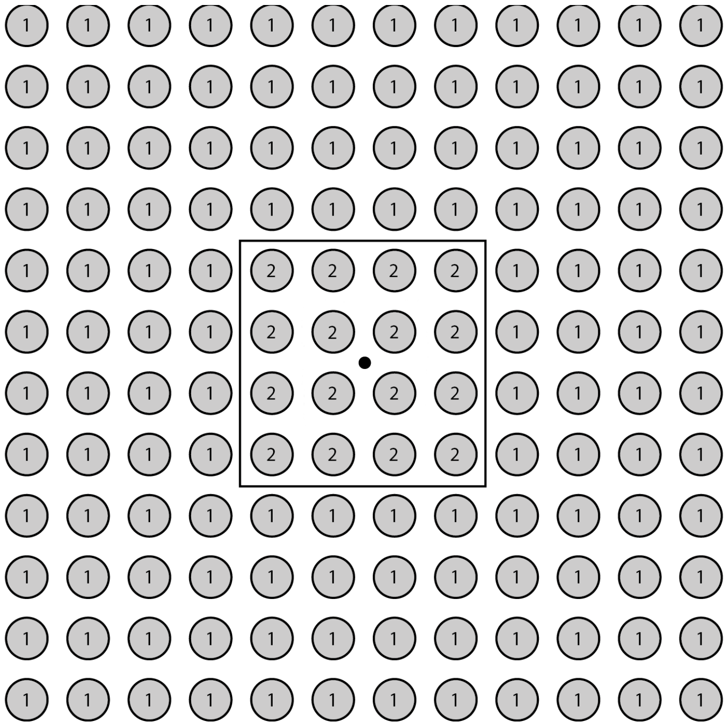

Fig. 13 Matrix 12x12

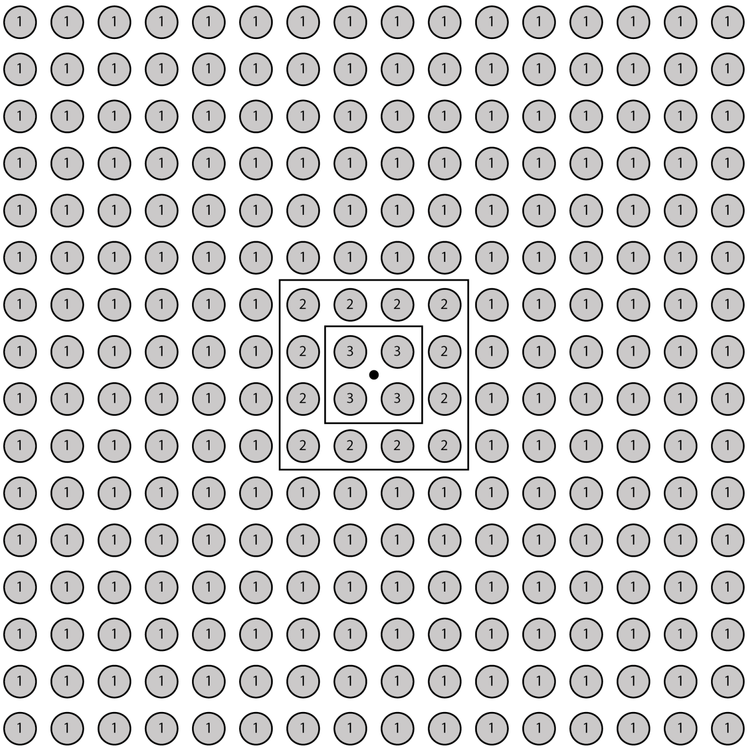

Fig. 14 Matrix 16x16

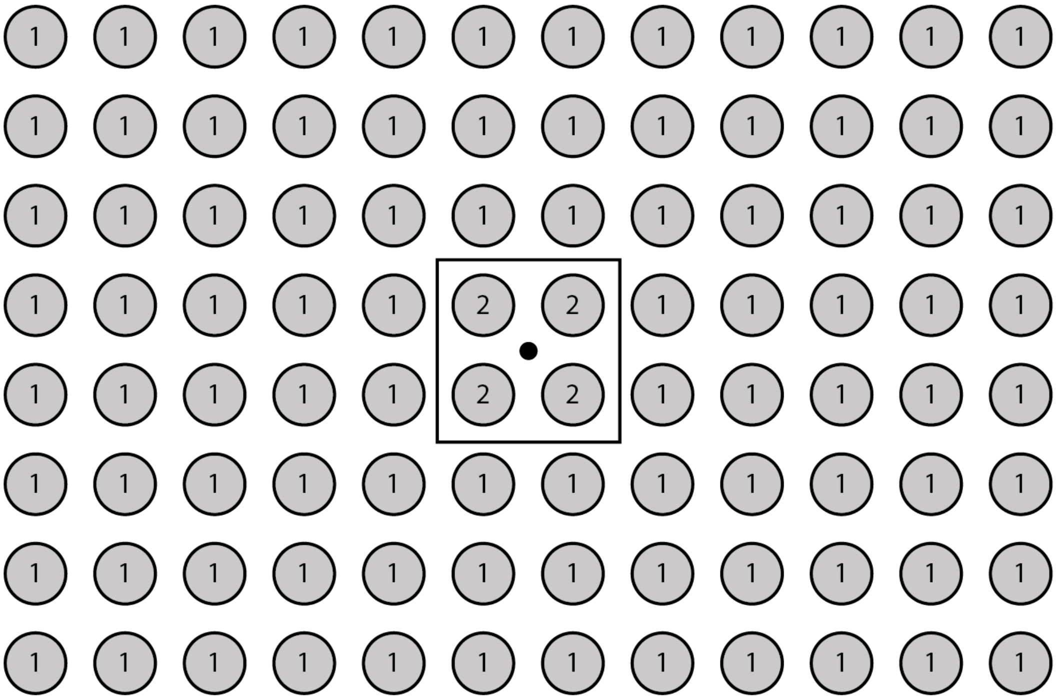

Fig. 15 Matrix 12x8

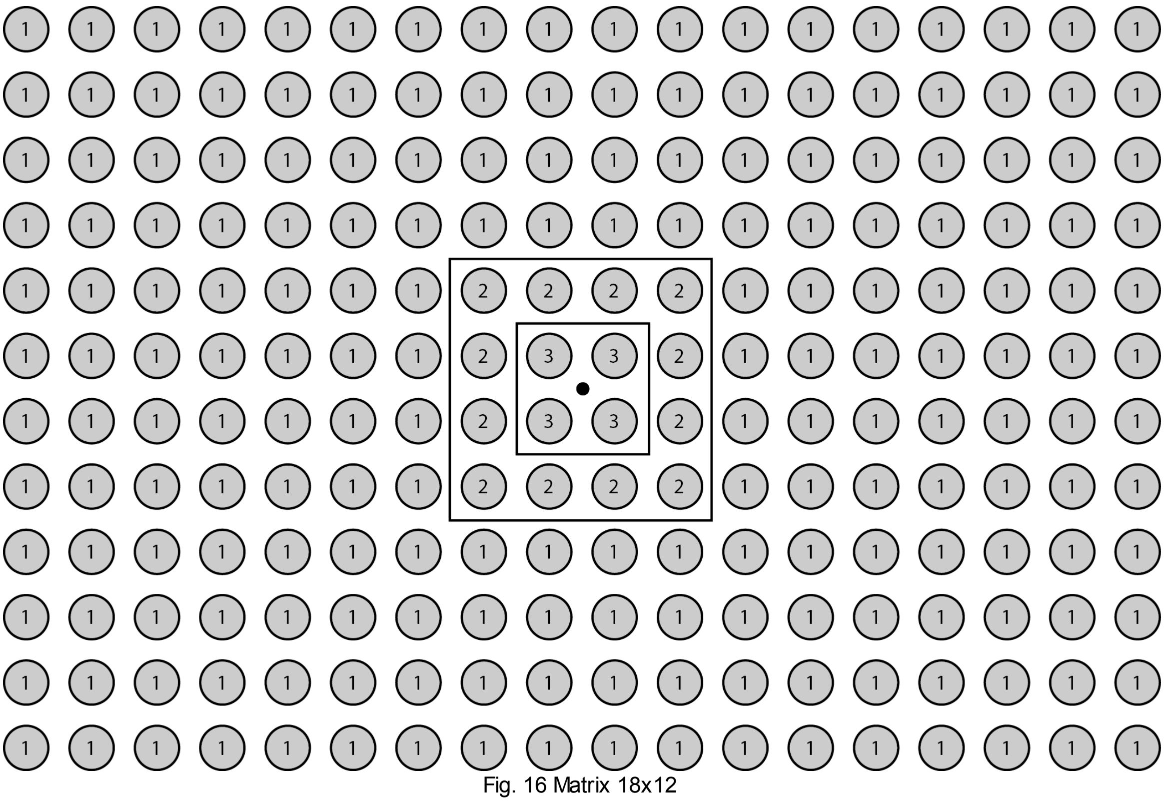

Fig. 16 Matrix 18x12

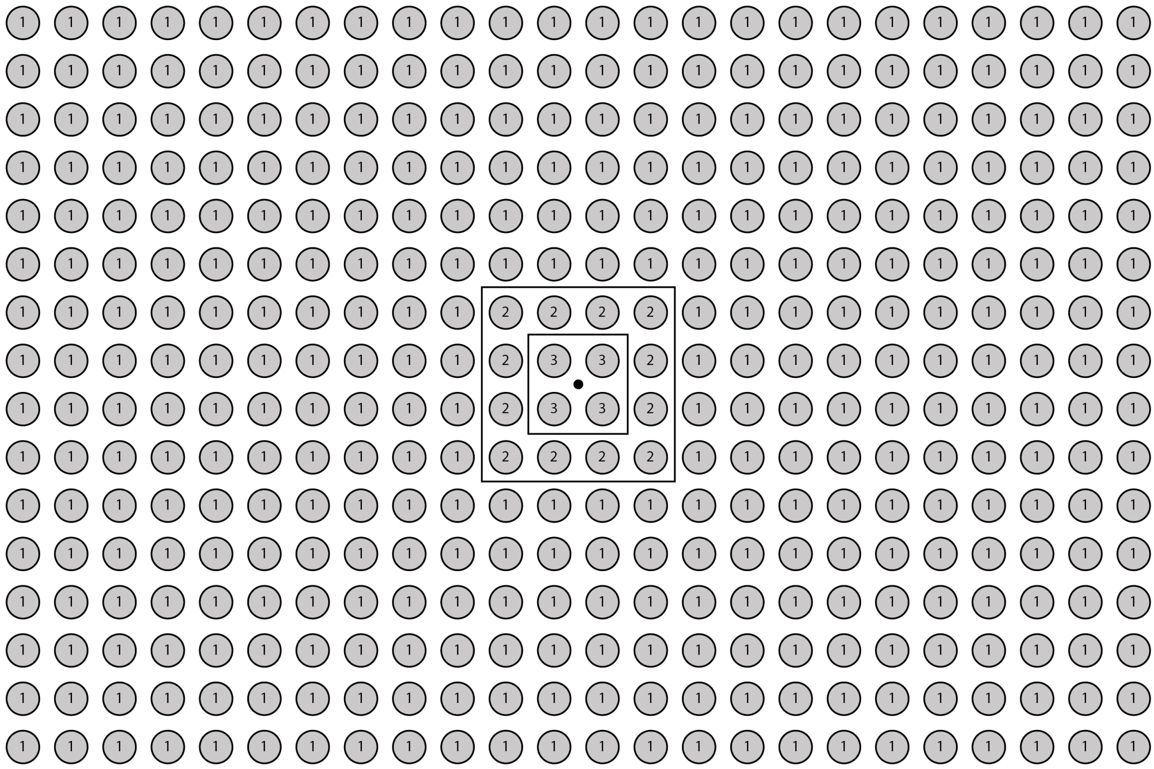

Fig. 17 Matrix 24x16

The fixation control happens randomly at a chance of 15% after each stimulus. Every fixation control should be answered by pressing the OK-button. If the fixation control is ignored 3 times in a row, a signaling sound will play to alert the client to it.

If the OK-button is pressed continuously, the test is interrupted. A signal sound will play and the test will be paused as long as the button is pressed. When the button is released, the test will continue.

Duration

Depending on the size of matrix chosen and on which eye to check, the test should take between 2 and 15 minutes.

3.3 Evaluation

Basic information about the result evaluation of the screening results can be found in the RehaCom manual, chapter "Screening Results".

Overview of results

For the campimetry screening the Z-norm is taken into consideration. The Z-norm states how many stimuli were overlooked in relation to the total number of stimuli.

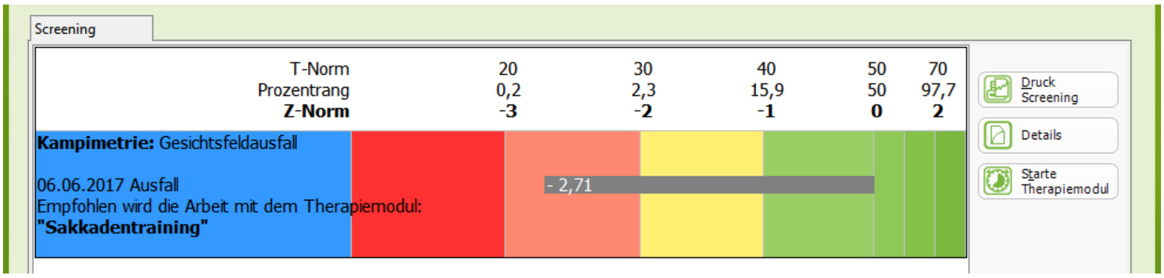

Fig.18: Overview of the results of a campimetry screening.

Detailed information about the screening process can be found in "Details" (see Fig. 18).

Details

The details page shows the evaluation parameters for all tests conducted.

On the right is a list of all tests in order of the time they were conducted. Entries that are marked with an asterisk (*) show tests that weren't completeted.

Every result selected (in the list on the right) is assigned a column in the table. The results are distinguishable by their different colours. The background colour of the entries on the list of all the tests (on the right) is the same as the colour of the column of the result in the table (middle).

The evaluation of the details shows a maximum of 3 results at the same time. The first and last test conducted are chosen automatically.

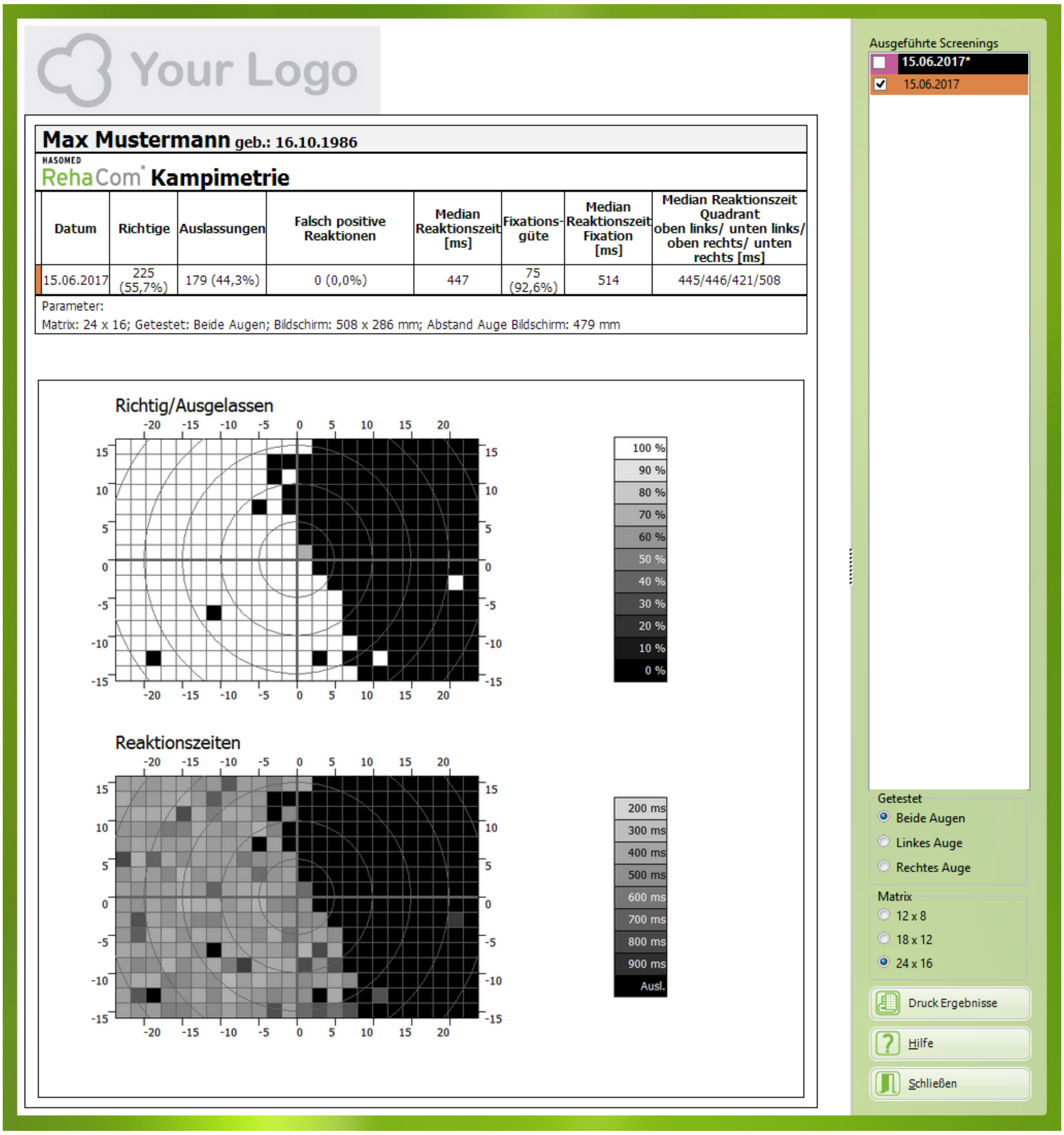

Fig.19: Detailed results of the campimetry results, w ith the list of tests on the right and evaluation tables and charts in the centre.

Colums of the results table:

Date Time at which the screening was conducted

Correct Number of correct reactions to a stimulus

Omissions Number of non-reactions to a stimulus

False positives Number of reactions before 150 ms

Median Response Time (ms)	Median of all response times in ms
Fixation quality	Number of reactions to central fixation stimulus
Median Response Time Fixation	Median of all response times to central fixation stimulus in ms
Median Response Time Quadrant	Median of all reaction times in every quadrant: o upper left o lower left o upper right and o lower right

Furthermore, there are two charts showing the reaction time and the quality of the reactions.

The evaluation of the respective eyes and the different matrix sizes can be checked in the boxes on the right. The charts will change according your selections.

The "Correct/Omission" chart shows which point was responded to at what rate. The rate is realized in a grey scale. Matrix fields that are filled in with a dot signify false positives. Matrix fields that are grey show points that were evaluated more than once during the test. Those points produced both correct reactions and omissions.

The "Response time" chart shows how quickly a point was reacted to. The response times are indicated by the grey scale. To interpret the shades of grey you can look at the key on the side. The faster the response time, the lighter the matrix field will appear. The times (ms) shown on the key always represent the shortest time of the shade shown. In the chart of the response times intermediate values are calculated for the shades according to the response time. For example, a response time of 250 ms would have a shade of grey in between the shades of 200 and 300 ms as they are shown on the key.

Layering of screenings

A maximum of three results can be layered over each other. To do this choose the screenings from the "Completed screenings" list. In the "Correct/Omissions" and the "Response time" charts, the average calculated will be shown.
Please note: Only those results that were attained using the same parameters (identical screen sizes, same distance of the client to the screen, same matrix) can be layered.

4 Bibliography

Schmielau, Wong (2007) Recovery of visual fields in brain-lesioned patients by reaction perimetry treatmen

Kasten, Wüst, Behrens-Baumann, Sabel (1998). Computer based training for the treatment of partial blindness. Nature Medicine. Nr. 4, S. 1083-1087

Poggel, Müller, Kasten, Sabel (2008). Multifactorial predictors and outcome variables of vision restoration training in patients with post-geniculate visual field loss. Restorative Neurology and Neuroscience. Nr. 26, S. 321-339

Schlüter, Schulz, Kenkel, Romano (2009). Functional Improvements after a Visual Rehabilitation Intervention for Patients with Homonymous Visual Field Defects. Poster presented at the Annual Meeting of the American Academy of Neurology, Seattle, April 26-May 2, 2009

de Haan GA, Melis-Dankers B, Brouwer WH, Tucha O, Heutink J.(2016) The Effects of Compensatory Scanning Training on Mobility in Patients with Homonymous Visual Field Defects: A Randomized Controlled Trial. PLoS One. 2015 Aug 14;10 (8):e0134459. doi: 10.1371/journal.pone.0134459. eCollection 2015.

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Kerkhoff, Oppenländer, Finke, Bublak (2007). Therapie cerebraler visueller Wahrnehmungsstörungen. Der Nervenarzt, Nr. 78, S. 457–470