HASOMED

RehaCom®

Cognitive therapy

Saccadic Training

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HASOMED RehaCom®

Cognitive therapy

by HASOMED GmbH

This manual contains information about using the RehaCom therapy system.

Our therapy system RehaCom delivers tested methodologies and procedures to train brain performance.
RehaCom helps patients after stroke or brain trauma with the improvement on such important abilities like memory, attention, concentration, planning, etc.

Since 1986 we develop the therapy system progressive. It is our aim to give you a tool which supports your work by technical competence and simple handling, to support you at clinic and practice.

User assistance information:

Please find help on RehaCom website of your country. In case of any questions contact us via e-mail or phone (see contact information below).

Germany / Europe / Worldwide:
HASOMED Hard- und Software für Medizin Gesellschaft mbH
Paul-Ecke-Str. 1
D-39114 Magdeburg

Tel: +49 (391) 610 7645
www.rehacom.com
info@rehacom.com

Dear user,
please read the entire instruction manual before trying to operate RehaCom.
It's unsafe to start using RehaCom without reading this manual.
This manual includes lots of advice, supporting information and hints in order to reach the best therapy results for the patients.

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1 Description of the training

1.1 Training tasks

The RehaCom training module **Saccadic Training** is a very realistic type of training. It helps the patient to be able to transfer what he or she learns and to maintain motivation.

The scenario within the training starts off with the patient "standing on the side of a mountain" observing the horizon (see Fig. 1). The patient's point of view is drawn towards a focal point: a yellow sun, which appears in the middle of the screen but can also be positioned to the left or right side. The patient's task is to recognize objects which appear on the horizon and confirm their appearance by pressing the appropriate key on the RehaCom Keyboard.

Objects with varying levels of contrast are used: silhouettes of vehicles and animals (high level of contrast - easier) and drawings (with a low level of contrast - more difficult). The objects appear on a line (horizontal line) which separates the countryside from the light blue sky. This line serves as "guide" for the patient as he or she searches for objects. By supporting the search for objects with a guide line, the module draws on similarities with other modules for saccadic training and field of vision development.

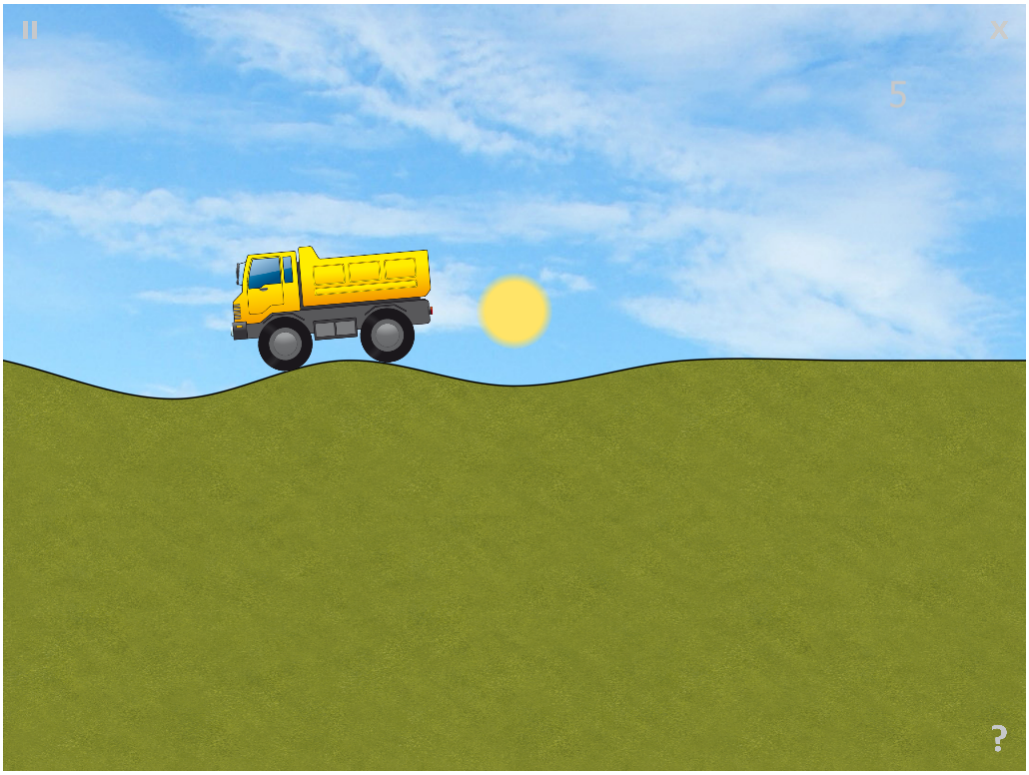

Fig. 1: The training where the horizontal line is being used as a guide.
(Point of focus - middle - large object, a simple rolling horizontal line)

At higher levels, the horizontal line is not used to guide the patient. Instead, an object has to be spotted in a sky (see Fig. 2). At the bottom of the screen, a sky line can be seen. As a point of focus, a white moon is used. In this night sky, flying objects appear (e.g., helicopters, airplanes, rockets, zeppelins).

The module works in an adaptive way.

Fig. 2: Training without horizon line

When working with the module at higher levels, a number of different tasks that can be set up or varied in the parameter menu are presented to the patients.

Each task is dependent, in various phases, on the chosen training mode.

Middle fixation point, Double object disabled

1. The patient focuses on the sun or the moon and waits for an acoustic signal after which an object appears on the left or the right of the sun or moon.
2. The patient's task is to clarify if the object appeared to the left or right of the focal point by pressing the left arrow or right arrow on the RehaCom keyboard. The object then disappears from the screen.

Left or right fixation point, Double object disabled

1. The patient focuses on the sun or the moon and waits for an acoustic signal. After this signal, there is a 50% likelihood that an object appears contralaterally

to the focus point; otherwise, no object is shown.
2. If an object appears, the patient has to press the **OK** button quickly. If no object appears then no button should be pressed.

Double object enabled

1. The patient focuses on the sun or the moon and waits for an acoustic signal. After this, there is a likelihood of 50% that two objects are shown on the screen, approx. 25% likelihood for 1 object to appear, and 25% for no objects.
2. The patient should react when **2 objects** appear on the screen. In all other cases there should be no reaction at all. Here higher demands are made on the patient's scanning ability.

The reaction time can be set up in the parameter menu. Patients are notified of their errors visually. Afterwards, a new landscape appears and the course of events begin again after a re-defined interstimulus interval (within +-50% of the interstimulus interval parameter setting).

After processing the determined number of items in a task, the level is then ended. The patient's performance is evaluated and the level of difficulty is adjusted based on that performance.

If necessary, a fixation control can be enabled. This alters the sun from yellow to red in stochastic intervals (accounts for approx. 10% of all items in a task). When the sun changes to red, the patient must acknowledge this by immediately pressing the **OK** button.

The input method has been deliberately designed to be as simple as possible. In general, only the **OK** button has to be used. Only when the focal point is in the middle and the Double object parameter is disabled, the right arrow and left arrow are required to indicate on which side of the focal point the stimulus appeared.

It is recommended that with patients who suffer from visual disabilities, a therapist should be available at the beginning of the training to help understanding the task.

Optionally the training procedure can be practiced with an exemplary **exercise** after the instructions. When at least five objects have been presented and the last two reactions have been correct, the exercise counts as finished and the actual training begins.

1.2 Performance feedback

Performance feedback is available at all levels. If the patient makes an incorrect decision or if the patient reacted when no object was shown, a striking, large, red reference field always appears with the word *Incorrect* as visual feedback. There is no similar feedback displayed for correct decisions.

If a patient reacts in the interstimulus interval, an error tone is sounded.

After each level is completed, the number of correct decisions is then calculated as a percentage of the total number of stimuli presented, and it is then determined whether the level of difficulty will change. In addition, there is also verbal feedback in the form of words of encouragement.

If the patient reacts too slowly (i.e., exceeds the max. reaction time) a piece of advice (e.g., "You must react more quickly") is displayed.

1.3 Levels of difficulty

The level of difficulty is varied in several ways:

- different types of horizons,
- different degrees of size in the objects,
- the movement of the object and/or its lack of motion,
- the distribution of the objects according to the visual angle degree and
- different types of contrast between the object/background.

There are six types of scenes, five of which have horizon line. Each type of scene requires a particular type of scanning ability:

- horizontal straight line,
- inclined straight line,
- simple hill,
- mountain,
- silhouetted skyline, and
- without horizon.

The details of the scene are deliberately simplistic so as not to distract from the main goal: the search for objects on the horizontal line. In the lower levels, the countryside below the horizontal line is not textured and changes between various solid colors: two different blue shades (sea), green shades (meadow), brown shades (soil), and yellow shades (sand). The sky is displayed by one of three different blue shades. In some of the median levels, the countryside consists of textured elements, and the same color distribution as for the lower levels was chosen. At some of the higher levels of difficulty, the guidance through the horizon line is omitted. In these levels, the countryside consists of a structured background, represented by the silhouette of a city or forest skyline. The highest levels of difficulty (Level 29–34) have no horizon line. In these levels, the view is changed from the side to the top. The various backgrounds consist of illustrations and thus increase the reality transfer.

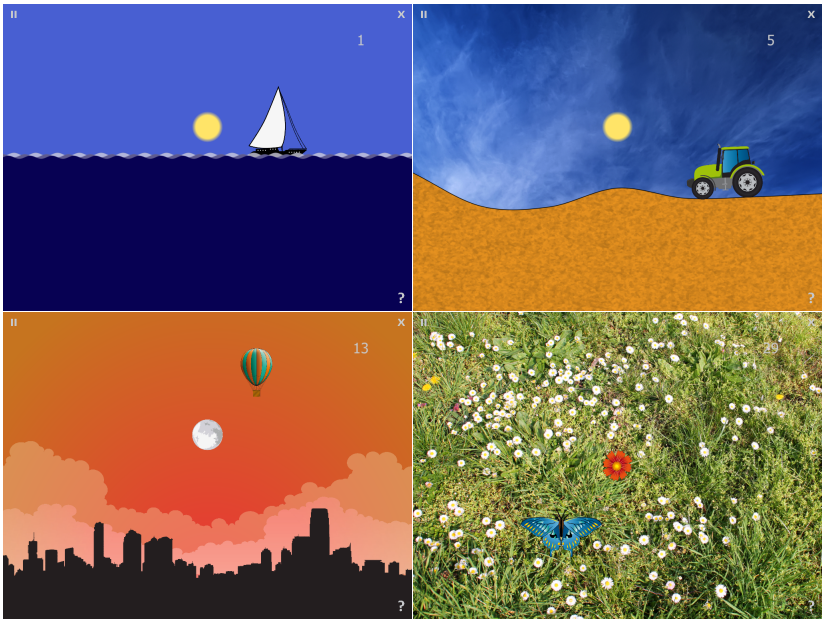

Fig. 3: Training surface in the different levels of difficulty (plain, textured, silhouetted, and pictured display).

The objects have level specific sizes and colors:

- large,
- medium, and
- small.

The contrast is defined as follows:

- high: black object in front of a light blue background; or white object in front of a night sky, and
- low: the color of the object is difficult to determine in front of a realistic background (clouds) and/or black night sky (photos).

Level	Picture size	Horizontal	Movement	Contrast	Visual Angle Degree	Texture
01	large	horizontal	with	high	4°	-
02	large	inclined	with	low	4°	-
03	large	simple	with	high	4°	-
04	large	mountain	with	high	4°	-
05	large	mountain	without	low	4°	X
06	large	simple	without	low	4°	-
07	large	mountain	without	high	4°	-
08	large	mountain	without	low	4°	X
09	large	simple	without	low	4°	-
10	medium	mountain	with	high	8°	-
11	medium	mountain	with	low	8°	X
12	medium	silhouetted	with	high	8°	-

13	medium	silhouetted	without	low	8°	-
14	medium	simple	without	low	8°	X
15	medium	mountain	without	high	8°	-
16	medium	mountain	without	low	8°	X
17	medium	silhouetted	without	high	8°	-
18	medium	silhouetted	without	low	8°	-
19	small	simple	with	high	12°	X
20	small	simple	with	low	12°	-
21	small	mountain	with	low	12°	X
22	small	silhouetted	with	high	12°	-
23	small	silhouetted	with	low	12°	-
24	small	mountain	without	high	12°	X
25	small	mountain	without	low	12°	-
26	small	mountain	without	low	12°	X
27	small	silhouetted	without	high	12°	-
28	small	silhouetted	without	low	12°	-
29	large	without	with	low	16°	-
30	large	without	without	low	16°	-
31	medium	without	with	low	16°	-
32	medium	without	without	low	16°	-
33	small	without	with	low	16°	-
34	small	without	without	low	16°	-

Tab. 1: Levels of difficulty

To assess the patient's performance, four different types of error must be considered:

- position error (only with the Fixation point is set to "Middle" while Double object is disabled),
- irretrievable error,
- fixation error, and
- time error.

Position errors occur when the patient presses the incorrect arrow button (e.g., object appeared on the left and the right arrow button was pressed).

Irretrievable errors can occur in one of two situations:
When Double object is disabled and Fixation point is not set to "Middle": if the **OK** button was pressed although no object was shown.
Double object enabled: if the **OK** button was pressed although no second object was shown.

A fixation error occurs when Fixation check is enabled and the patient does not react to the fixation control within the max. reaction time.

Time errors are counted if the patient reacts after the max. reaction time has run out.

When the item change is set to take place after an optimal reaction time (see Training parameters), a missing reaction within the optimal reaction time is recorded as a time error.

1.4 Training parameters

Specific settings for the training module can be adjusted (see Fig. 4). This section describes each setting and explains how to adjust them.

Skip tutorial:
The integrated tutorial can be skipped by the therapist if necessary. Therefore, the lower corner button  or button 0 (zero) can be used.

Fig. 4: Parameter menu

Duration of session in min:
A training period of 20–30 minutes is recommended.

Level up:
The number of correct decisions, omissions not counted, in reference to the total number of stimuli shown is calculated as a percentage. The level of difficulty increases when the percent correct exceeds the rate in the Level up parameter.

Level down:
The number of correct decisions, omissions not counted, in reference to the total number of stimuli shown is calculated as a percentage. The level of difficulty decreases when the percent correct falls below the rate in the Level down parameter. If the patient falls between these previously mentioned levels then a

similar level is repeated.

Number of items:
This parameter sets the total number of objects that are shown per level.

Interstimulus interval:
The time between the patient's reaction to an object and the appearance of the next object is stochastically determined to be within +-50% of the value in this parameter. If the distance between the appearance of objects is increased, then the patient has more time to prepare him- or herself for the next task. For patients with a high performance level, reducing the distance between the appearance of objects acts as an additional stress factor.

Optimal reaction time:
The time, which is available for an optimal reaction, is clearly defined. The measurement of the time starts like the maximum reaction time**,** when the object appears on the screen. In the performance evaluation, an exceeding of the optimal reaction time provides additional information for the therapist to consider but it is not considered an error unless the item is set to change once the optimal reaction time has run out.

Maximum reaction time:
The maximum time which is available for a reaction to the appearance of an object begins the moment an object appears on the screen. The maximum reaction time can be increased (e.g., by 10 sec) for patients at a lower performance level. When the maximum reaction time is increased, the focus of the training is on the recognition of objects, and the time stress factor is excluded. Performance is then assessed solely on the criterion whether the patient answered correctly. On the other hand, for patients with a high performance level, reducing the max. reaction time can also act as an additional stress factor to make the training more challenging.

Fixation point:
The fixation point can appear in one of three equal fields. The fixation point appears in one field and the object in another. When the parameter *Double object* is enabled, the fixation point is in one field and the objects appear in the other two fields. Where the fixation point appears has an influence on the strategy which should be taken. If it appears in the middle, then objects appear to the left and right. The angle for the saccadic training is then limited to half the width of the screen. This type of training is recommended for hemianopic patients. If the fixation point appears on the left or right, then the objects appear in a contralateral position. The saccadic training angle is larger when compared to the angles used while the fixation point is in the middle, and the angle is only limited by the width of the screen. This training is recommended for patients who suffer from Neglect and the training can be focused on the particular side or direction affected by the neglect.

When the fixation point is set to the left or right, 10% of the items appear in the strong area (i.e., with a fixation point to the left, 10% of items will appear to the left of

the fixation point; with a fixation point to the right, 10% of items will appear to the right of the fixation point).

Item change automatically to:
When this option is disabled, the stimulus remains on the screen until the patient reacts. If this setting is enabled, the stimulus appears for a set amount of time and then is replaced by the next stimulus. The items can be set to automatically change once either the optimal reaction time or max. reaction time has run out. If the change is set after optimal reaction time, the evaluation system evaluates the missing reaction during the optimal reaction time as an error.

Fixation check:
When the fixation control is enabled, the fixation point changes periodically (e.g., sun changes from yellow to red, moon changes from white to yellow); this accounts for up to 10% of the items within a task. When the fixation point changes, the patient must press the **OK** button.
If the patient doesn't notice these changes in the color, then a fixation error is registered. The patient is then informed that the error has occurred. A message appears on the screen "Please look at the sun." The fixation errors are not counted when determining whether the level of difficulty should increase or decrease. However, they appear in the training results for control purposes. Only use the fixation control when the patient clearly understands the training process. Otherwise, this can cause frustration which can complicate training.

Double object:
If the double object setting is enabled, the patient must react only when 2 objects appear on the screen. This places a higher demand on the patients scanning abilities.

Optokinetic stimulation:
Optokinetic stimulation with pursuit eye movements (PEM) is an effective method for the therapy of visual neglect (Kerkhoff 2000; Kerkhoff, Keller, Ritter,& Marquardt 2006). The presentation of many visual stimuli on the screen moving towards the neglected side can reduce the visual neglect significantly and durably. During the PEM therapy, point patterns are shown which move with constant speed of 5–50° to the left in the neglected half of the room. The patients are encouraged to follow the dots with their eyes, which means they have to make pursuit eye movements towards the neglected area. The flowing movement of small elements helps the patient with moving the eyes in a specific direction. The direction of movement depends on the patient-specific setting for hemianopsia. This can be found in the area *clients -> edit*, in the tab *file*. Depending on the disorder, the PEM is adjusted within the module. The values for the screen width and distance to the screen are used to determine the speed of the elements. As the screen gets larger, the speed of the moving elements slows. Also the moving elements slow down when the distance to the screen is decreased. Additionally, the speed can be adjusted individually by using the buttons **1** and **2**.

Moving objects:
This parameter, when enabled, sets the objects in motion. The objects move along the horizon line or freely across the screen. The corresponding levels with moving objects are shown in the Levels of difficulty.

Eye tracking:
When this parameter is enabled, eye movements are recorded during the time a stimulus is present on screen. Requirement is an eye tracking device with control over the mouse cursor (which is not visible during the training).

Zonal structure acc. to visual angle degree:
If this option is enabled, the stimuli are distributed with a predefined visual angle degree around the fixation point. The respective degree values can be found in the Levels of difficulty. The distribution on visual angle degree can be enabled only when the fixation point is set to middle because a consistent and visible distribution on the screen can be guaranteed only in this setting. The size of the visual angle degrees is calculated by the screen width and the distance to the screen. If this is not known, default values are assumed.

Default values:
When setting up training for the first time with a new patient, the following default values are automatically set up:

Duration of session:	25 minutes
Level up:	90%
Level down:	70%
Number of items:	30
Interstimulus interval:	3000 ms
Optimal reaction time:	500 ms
Maximum reaction time:	4000 ms
Fixation point:	Middle
Item change automatically to (opt. reaction time, max. reaction time)	Disabled (Enabled, Disabled)
Fixation check:	Disabled
Double object:	Disabled
Optokinetic stimulation :	Disabled
Moving objects:	Disabled
Eye tracking	Disabled
Distribution on visual angle degree:	Disabled

Tab. 2: Default parameters

1.5 Data analysis

All training sessions are placed in a chart within the Results tab (see Tab. 3). A training session is selected by double clicking on the bar in the chart. Once selected, the results of the session are presented in the Table and Chart tab.

Explanation of columns in the results table or under More Details on the results page

Level	Current level of difficulty
Stimuli	Number of stimuli
Correct le. half %	Correct reactions left half in %
Correct right half %	Correct reactions right half in %
Correct double obj. %	Number of correct reactions with double object enabled in %
Correct reactions top left	Number of correct reactions top left
Number correct reactions bottom left	Number of correct reactions bottom left
Correct reactions top right	Number of correct reactions top right
Number correct reactions bottom right	Number of correct reactions bottom right
Mistakes total	Number of mistakes total
Reac. time median le.	Median of all reaction times left in ms
Reac. time median ri.	Median of all reaction times right in ms
Reac. time median double obj.	Median of all reaction times of correct reactions with double object enabled in ms
Reac. time median top left	Median of all reaction times top left in ms
Reac. time median bottom left	Median of all reaction times bottom left in ms
Reac. time median top right	Median of all reaction times top right in ms
Reac. time median bottom right	Median of all reaction times bottom right in ms

Correct le. half	Number of correct reactions left half
Correct right half	Number of correct reactions right half
Mistakes direction le.	Number of incorrect direction choices left
Mistakes direction ri.	Number of incorrect direction choices right
Mistakes irritation	Number of mistakes irritation
Mistakes interstim.	Number of reactions during interstimulus interval
Omissions	Total number of omissions
Omissions left	Number of omissions left
Omissions right	Number of omissions right
Opt. reac. time not fulfilled le.	Optimal reaction time not fulfilled left
Opt. reac. time not fulfilled ri.	Optimal reaction time not fulfilled right
Omissions fixation	Number of mistakes during fixation control
Fixation checks	Number of fixation controls
Reac. time quartil1 le.	Reaction time quartile 1 left in ms
Reac. time quartil1 ri.	Reaction time quartile 1 right in ms
Reac. time quartil3 le.	Reaction time quartile 3 left in ms
Reac. time quartil3 ri.	Reaction time quartile 3 right in ms
Train. time task	Effective training time in h:mm:ss
Breaks	Number of breaks caused by the client

Tab. 3: Results

The parameter settings used during the training are displayed directly below the table on the Table and Chart tab. The graphical presentation of the results (e.g., percent correct fixation checks, percent correct stimulus) is also displayed on the Table and Chart tab.

(Results with "ri." (right) are 0 (zero):

- if fixation point is not middle,
- if training mode is Double object, or
- if result data are from training with version before 5.3.)

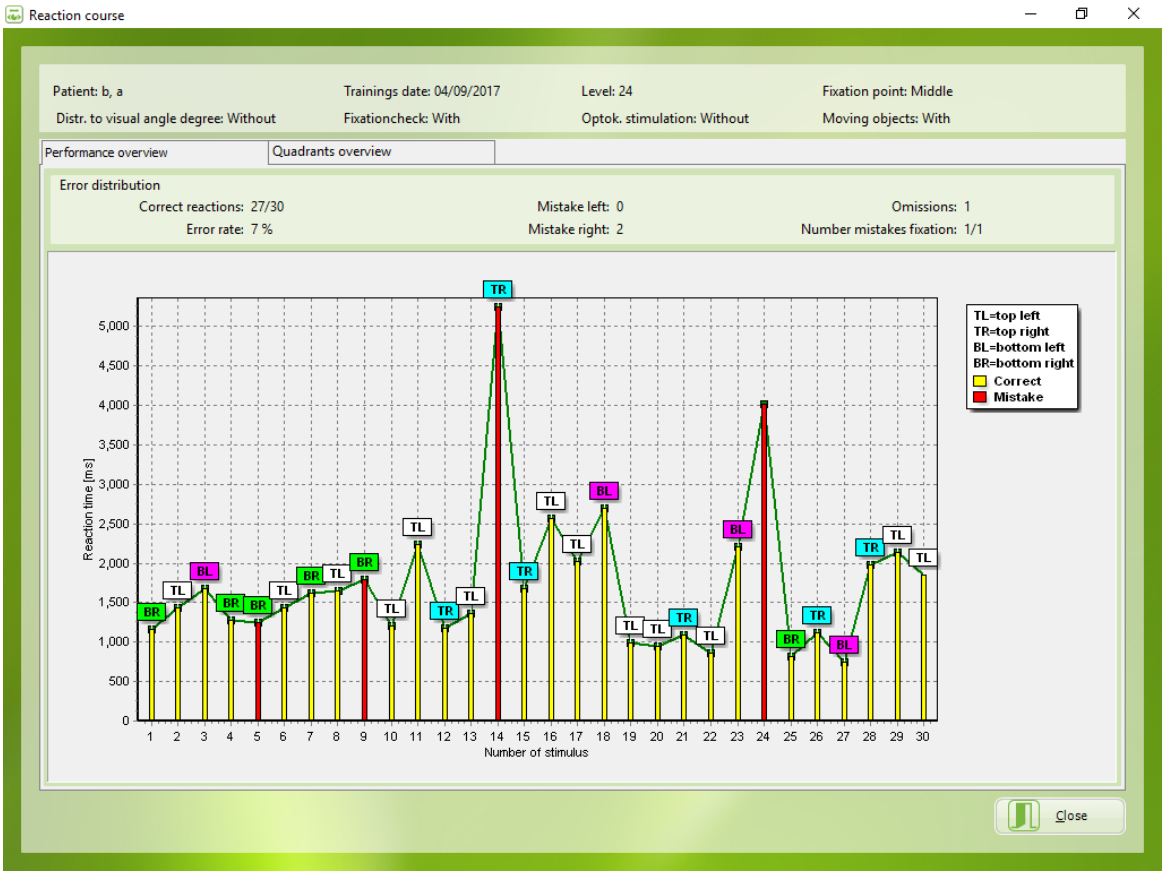

Fig. 5: Performance graph and error distribution in a level.

In the upper region of the window *Reaction course* (see Fig. 5), the level and the parameter settings are shown. Directly below in the performance overview tab are data about the error distribution.
The reaction time for each item can be taken from the represented performance graphic. On the y-axis the reaction time in ms, and on the x-axis, the associated item number is given. If there was an incorrect reaction in a task, it is marked with a red bar. Correct reactions are marked with a yellow bar. Each response is marked above the bar with the abbreviation of the associated quadrant for the reaction. Bars without quadrant abbreviations represent reaction data to the fixation control. If these reactions have taken place in the specified time frame they are marked by the corresponding color. If the setting is double object, there is no quadrant mark shown because the representation of the items is not limited to one quadrant.

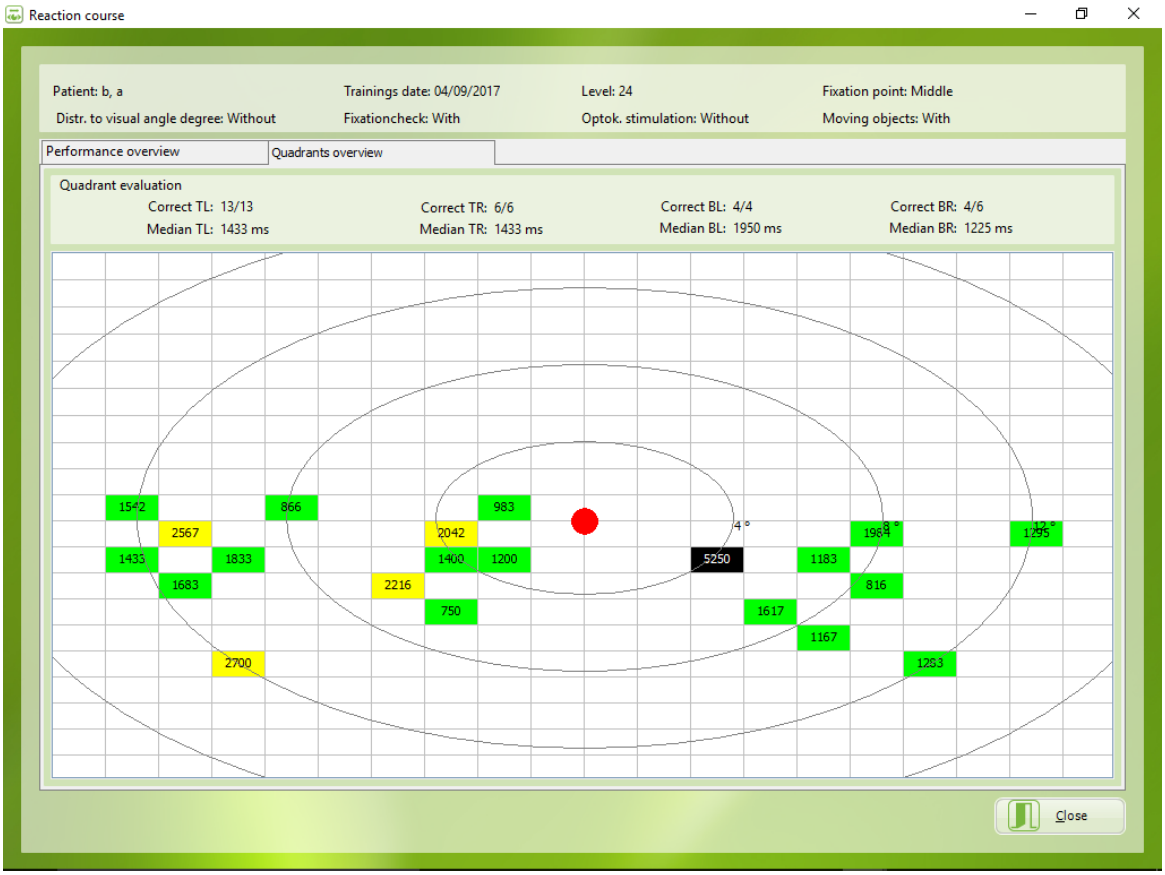

Fig. 6: Quadrant overview and quadrant analysis in a level.

Above the quadrant matrix, the quadrant analysis of the single quadrants can be seen. The number of correct reactions and the median of all reaction times in the respective quadrant are shown. In the graphic, the fields in which an item appeared, are marked with specific colors. Depending on the reaction time, the color distribution from 0 to the maximum reaction time is composed as follows: green, yellow-green, yellow, and orange. Black is used for omissions. The fixation point is marked by a clearly visible point. Depending on the set fixation point, it could be positioned on the left, in the center, or on the right. In addition to the fixation point, the positions of the visual angle are drawn. Thus, weaknesses of the reaction time in a certain quadrant can be recognized by the colored markers. Particularly omissions (no reactions) catch the eye by their black color immediately.

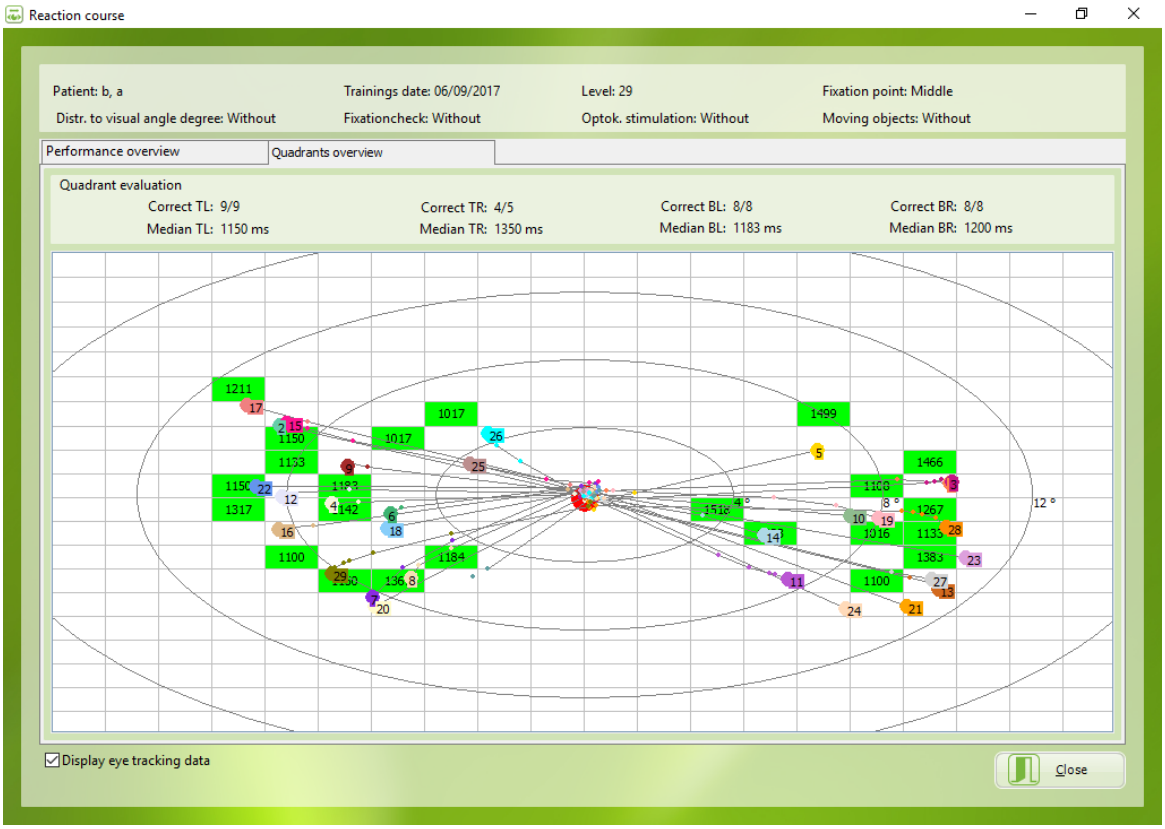

Fig. 7: Quadrant overview with eye tracking data.

Has the eye tracking parameter been activated for the given training, the the recorded eye movements are displayed inside the quadrant matrix as well, labeled with numbers indicating the corresponding stimulus number (see Fig. 7).

Because of this detailed analysis of the training's reports, it is possible to indicate deficits to the patient and to draw conclusions for further training.

2 Theoretical concept

2.1 Foundations

The two main reasons that lead to a loss in the visual exploration (or which have a negative influence on visual exploration) in one or in both halves of the brain as a result of an injury to the brain are:

- impairments to field of vision and
- visual neglect.

Impairments to the field of vision are the most common kind of sensory disturbance after injuries to the brain.

The restrictions in the visual range caused by deficits to the field of vision generally lead to a reduction in visual exploration.

Clinical discoveries have shown that only 9% of the patients with homonymous hemianopsia and approximately 15% of the patients with quadrantenanopsia (total group 10%) show a residual field of vision of more than 10% and therefore have a presumably sufficient visual range and unaffected visual exploration.

On the other hand, patients with a residual field of vision under 10 degrees have been shown to have a clear disability caused by the loss in the field of vision. The reason for this is that the spontaneous eye and head movements do not compensate for what is lacking in the field of vision (Zihl & von Cramon, 1986).

Patients with unilateral neglect are incapable of reacting to stimuli which present themselves in a contralateral position to those areas in the brain where the lesion occurred (Heilman, 1985). These patients are greatly affected by this in all areas of their everyday life. As a result, all aspects of these patients' everyday lives are greatly affected. They find it difficult to negotiate their general environment, bumping into objects on their visually weak side and injuring themselves, because they are incapable of registering any sort of a threat on this side. Patients with unilateral neglect are also greatly restricted, because they are incapable of reacting to contralateral stimulus, when ipsi-lateral stimulus is presented at the same time. This is known as the extinction phenomenon (Heilman, 1985; Poeck, 1989).

As most problems, occurring in connection with unilateral neglect, can be traced back to visual degradation phenomena, the emphasis in the training is on a purposeful functional training of compensatory strategies in order to improve the visual exploration (Säring, 1988).

Due to the everyday relevance and nature of these abilities, which are damaged by hemianopic impairments and neglect, the necessity for compensatory training is then quite clear.

A possible treatment of the disturbances to visual exploration lie in the enlargement of the saccadic searching motion (scanning ability) of the eye. An increase in the amplitude of the scanning ability leads to a noticeable increase in the searching areas of the affected half of the visual field (Zihl, 1988).

2.2 Training aim

The **Saccadic Training** module was designed to help patients with visual deficits due to neglect or hemianopsia or to help patients with general restrictions in their field of vision or in their visual efficiency.

The aim of the training is to train compensatory strategies in cases of visual neglects and/or an enlargement in the patient's field of vision.

2.3 Target groups

The training is recommended for patients who suffer from impairments to their visual exploration as a result of visual field loss and visual neglect.

Because the module uses nonverbal material, it can also be used to train patients who have limitations in speech and comprehension of vocabulary.

The training can also be used with children from the age of 8 and up.

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