



## Saccadic Eye Movement

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The logo for HASOMED, featuring the word "HASOMED" in a bold, green, sans-serif font. The letters "H" and "M" are stylized with a black ECG-like waveform line passing through them.

Hard- und Software für die Medizin

# RehaCom<sup>®</sup>

## Computer-assisted cognitive rehabilitation

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*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.

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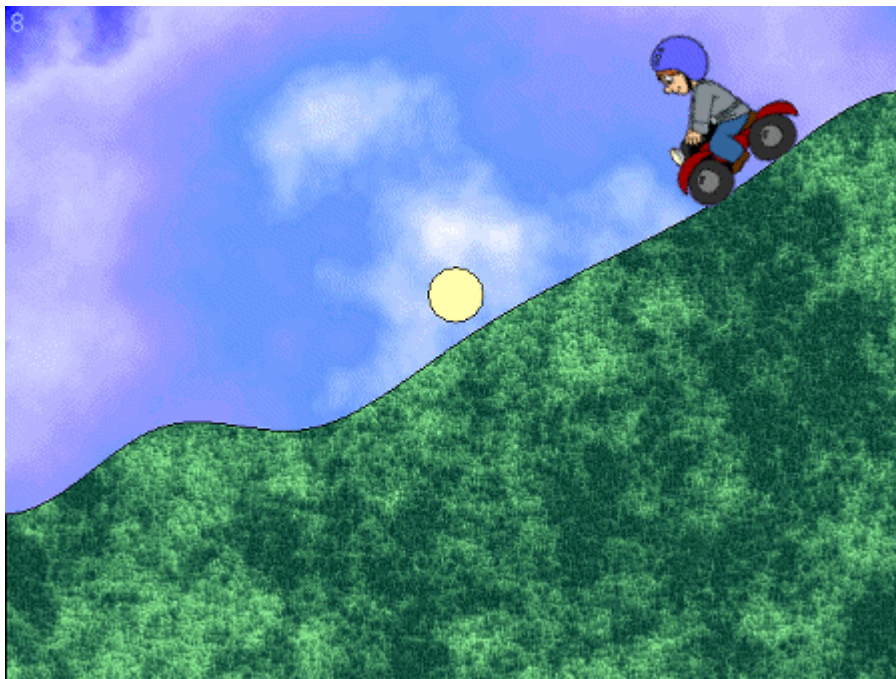
# 1 Description of the training

## 1.1 Training tasks

The RehaCom training procedure **Saccadic Eye Movement** is a very realistic type of training. In maintaining this closeness to reality the patient can maintain and improve on their level of motivation.

In the training the patient is "standing on the side of a mountain", observing the horizon (see Picture 1). The patient's point of view is drawn towards a focus point - a yellow sun, which appears in the middle of the screen but can also be positioned on the edge of the screen. 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 panel.

Objects which are easy to differ 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 searches for objects. By supporting the search for objects with a guide line, the procedure draws on similarities with other procedures for saccadic eye movement and field of vision development.

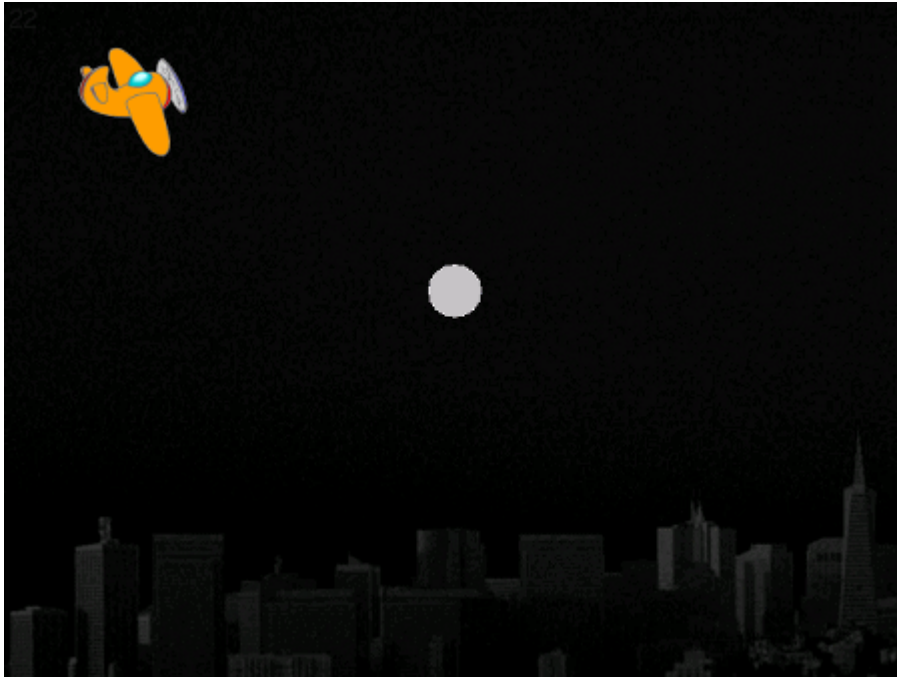


*Picture 1.* The training where the horizontal line is being used as a guide. (Point of focus - middle - large object, a simple rolling horizontal line)

At higher levels the horizontal line is not used to guide the patient. At the higher levels an object has to be spotted in a night sky (see picture 2). At the bottom of the screen a sky line can be seen. As a point of focus the a whit moon is used. In

this night sky flying objects appear: Helicopters, aeroplanes, rockets and zeppelins etc.

The procedure works in an adaptive way.



*Picture 2.* Training "Night sky"

When working with the procedure at higher levels a number of different tasks, which 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.

***Focus point "Middle", "Double object" not active***

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 and/or moon.
2. The patients task is to clarify if the object appeared on the left or the right of the focus point. He does this by pressing the "arrow left" or "arrow right" keys on the RehaCom - panel. The object then disappears from the screen.

***Focus point "left" and/or "right", "Double object" not active:***

1. The patient focuses on the sun or the moon and waits on an acoustic signal. After this an object is shown, with a likelihood of 50%, contra laterally to the focus point or no object is shown.
2. When an object appears the OK-key has to be pressed immediately. Then the object disappears from the screen. If no object appears then none of the keys should be pressed.

**"Double object" active:**

1. The patient focuses on the sun or the moon and waits on an acoustic signal. After this and with a likelihood of 50% 2 objects are shown on the screen, with approx. 25% likelihood for 1 object and 25% for none.
2. The patient should react when he recognizes **2 objects**. In all other cases he should not react at all. Here higher demands are made on the patients scanning ability.

The reaction time can be set up by the patient in the parameter menu. Patients are notified of their errors visually. A new landscape appears then appears and the course of events begin again and the task is re-defined by the item distance (+/-50%).

After processing the determined number of items tasks, the level of difficulty is then ended. The patient's performance is evaluated and the patient is informed as to whether he should continue with the same level of difficulty or switch to a higher or lower level of difficulty.

If required a method of control is available. This alters the sun from yellow to red in approx. 10 % of every tasks. The patient must be acknowledge this alteration by immediately pressing the OK-key.

The input method has been deliberately designed to be as simple as possible. In general only the OK-key has to be used. Only when it comes to the task **Focus point "middle"**, **"Double object"** not active are the keys "arrow right" and "arrow left" required to indicate direction.

In the instructions short sentences are used to clarify the training to patients. The patients quickly gathers how the system works. However, it is recommended that with patients who suffer from visual disabilities, a therapist should be available at the beginning of the training.

## 1.2 Performance feedback

As with all the RehaCom procedures a performance feedback facility 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 denotation "incorrect", as visual feedback. Correct decisions are not displayed.

If a patient reacts in the inter stimulus interval an error tone is sounded.

After completion of each level the correct number of decisions is then calculated as a percentage and it is then established as to whether the patient should change to a different level of training. In addition, there is also a verbal feedback facility which sounds words of encouragement.

If the patient reacts too slowly (i.e exceeds the **max. reaction time**) a piece of advice "You have to work a bit faster" is displayed.

### 1.3 Structure of the level of difficulty

Modifications to the level of difficulty are as follows:

- different types of horizons,
- different degrees of size in the objects,
- the movement of the object and/or its lack of motion and
- different types of contrast between the object/background.

5 horizon forms, with increasing difficulty, are used. In each case, these require a particular type of scanning ability:

- horizontal straight,
- inclined straight (defined in point 2),
- simple rolling line (defined in point 3),
- double rolling line (defined in point 5) and
- Night sky.

The countryside below the horizontal line is not structured and changes from dark blue(sea), green(meadow), brown(fields) and yellow(sand). The details of the countryside are deliberately simplistic so as not to distract from the main goal -the search for objects on the horizontal line.

The objects have details which are level specific:

- 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 colour of the object is difficult to determine in front of a realistic background (clouds) and/or black night sky (Photos).

*Structure of the level*

<b>Level</b>	<b>Picture size</b>	<b>Horizontal</b>	<b>Movement</b>	<b>Contrast</b>
01	large	horizontal	without	high
02	large	Line	without	high
03	large	simple	without	high
04	large	mountain	without	high
05	large	mountain	without	slight
06	large	simple	with	high
07	large	mountain	with	high
08	large	mountain	with	slight
09	medium	simple	without	high
10	medium	mountain	without	high
11	medium	mountain	without	slight
12	medium	simple	with	high
13	medium	mountain	with	high
14	medium	mountain	with	slight
15	small	simple	without	high
16	small	mountain	without	high
17	small	mountain	without	slight
18	small	simple	with	high
19	small	mountain	with	high
20	small	mountain	with	slight

from level 21 the procedure changes to the night sky mode

21	medium	without	without	high
22	medium	without	without	slight
23	medium	without	with	high
24	medium	without	with	slight
25	small	without	without	high
26	small	without	without	slight
27	small	without	with	high
28	small	without	with	slight

In order to assess the performance one must differ between three types of error:

- Position error (only with Focus point "middle", Double object not active)
- Irretrievable error and
- Time error



Position errors occur when the incorrect directional (e.g. Object appeared on the left and the keys "arrow right" was pressed).

Irretrievable errors are also registered with:

Double object not active and Focus point not "middle": if the OK-key was pressed although not object was shown.

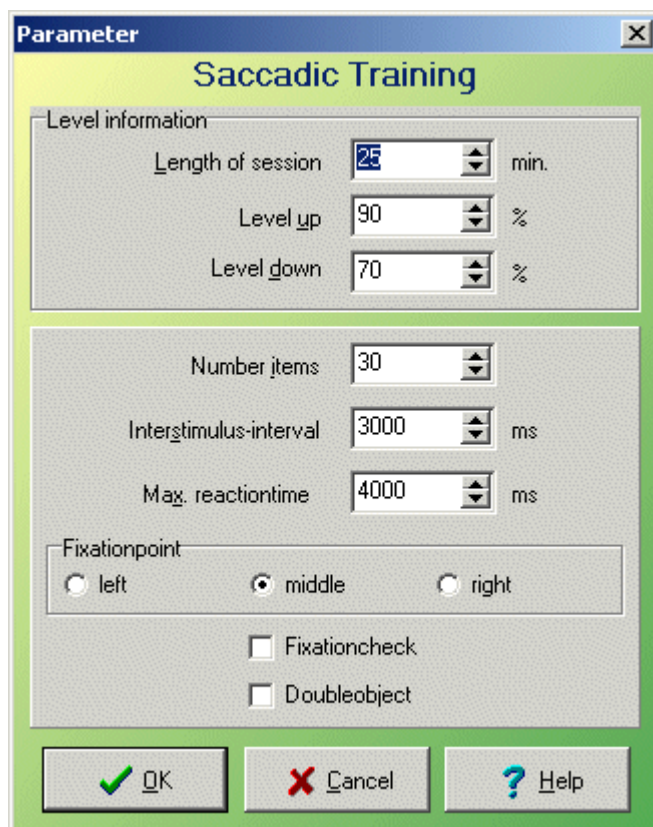
Double object active: if the OK key was pressed although a second object was not shown

Time errors are counted if the patient exceeds the max. reaction time available.

## 1.4 Training parameter

In the **RehaCom basic foundations**, some general information (references) is given on the Training Parameters and their properties. This information (references) should be taken into further consideration.

Picture 4 shows the parameter-menu.



Picture 4. Parameter-Menu.

### **Consultation duration in min:**

A training period of 20 to 30 minutes is recommended.

***Continue to the next level:***

After the patient has worked through the established amount of items, then the number of correct decisions is calculated as a percentage. The total number of correct decisions is looked at in relation to the total number of items. If the percentage calculated exceeds the established level for "continue to the next level" then the patient may continue to the next level of difficulty.

***Repeat previous level:***

If the percentage level is below the established level for "repeat previous level" then the patient falls back to lower level of difficulty. If the patient falls between these previously mentioned levels then a similar level is repeated.

***Number of Items:***

The number of tasks (items) per level is clearly set.

***Inter stimulus interval:***

The time between the patient's reaction to an object and the appearance of the next object is clearly established. The time span between the appearance of objects is stochastically set up in intervals of  $\pm 50\%$ . If the distance between the appearance of objects is increased, then the patient has more time to prepare himself 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. The number of the tasks to be processed in the given period of time is then increased.

***Maximum Reaction Time:***

The maximum time which is available for a reaction to the appearance of an object is clearly defined. The measurement of the reaction time 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. Here the focus of the training is on the recognition of objects. The time stress factor is excluded. Performance is assessed on the basis of "correct decision" only. On the other hand, for patients with a high performance level, reducing the max reaction time can also act an additional stress factor.

***Focus point place:***

In choosing the focal points one must consider that during the training the screen is divided into 3 identical fields. In the first mode the focus point is in one third and the object in another. In the mode **Double object**, the focus point is in one third and objects appear in the other two thirds. the choice of the focal point has an influence on the strategy which should be taken. If the focal point "middle" is chosen than objects appear to the left and the right of the focus point. The angle for the saccadic eye movement is then limited to half the width of the screen. This type of training is recommended for haenmian optical patients. If the focal point "left" or "right" is used then the objects appear in a contra lateral manner. The saccadic eye movement angle, when compared to the Fixation "middle" becomes larger and 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 where the neglect has most effect.

***Focus point control:***

When the focus point control is activated, the sun alters from yellow to red and/or the moon alters from white to yellow, with a likelihood of 10%. The patient must press the OK-key when these alterations occur. Naturally he can only do this when he observes the sun or the moon.

If the patient doesn't notice these changes in the colour then a focal point failure is registered. The patient is then informed as to the error which has occurred. A piece of advice appears on the screen "Please look at the sun". The focal point control errors are not counted in the assessment which determines whether the patient should continue to the next level or repeat a previous level. However they appear in evaluation for control purposes. The Focus point control should only be activated when the patient clearly understands the training process. Otherwise, this can lead to irritation which can complicate training.

***Double object:***

If the "double object" option is activated then the patient should only react when 2 objects appear on the screen. This places a high demand on the patients scanning abilities.

*default-Parameter:*

Duration of consultation:	25 Minutes
Continue to the next level:	90%
Repeat previous level:	70%
Number of Items:	30
Inter stimulus interval:	3000 ms
maximum reaction time:	4000 ms
Focus point:	Middle
Focus control:	off
Double object:	off

## 1.5 Evaluation

The diverse possibilities of data analysis for the determination of the further training strategy are described in the **RehaCom basic foundations**.

In the pictures as well as the tables, alongside the setting for the trainings parameter, the following information is available:

Level	current level of difficulty
Training time (effective)	effective Training time
Pauses	Number of pauses by the patient

# Stimuli	Number of objects
# Errors Direction	Number of incorrect direction choices (only during focus point "middle", "Double object" not active)
# Errors Reaction time	within the "max. reaction time" - there was no reaction
# Errors Irretrievable	there was a reaction ,although the was no object shown
# Total errors	Errors without double errors ( a late additional reaction whereby the wrong key was pressed does not count as a double error)
Reac.-time Quartile1	Reaction time 1. Quartile in ms
Reac.-time Median	Reaction time Median in ms
Reac.-time Quartile 3	Reaction time 3. Quartile in ms in the measurement of reaction time only the correct reactions are counted the error reactions are not counted.
#. Focus control.	Number of focus point controls
#. Error by focus	Number of errors during focus point control
#. Reac. Inter.stim.	Number of reactions in the Inter stimulus interval

In this way it is possible to give the patient advise on their short-comings.

## 2 Theoretical concept

### 2.1 Basic foundations

Two main reasons for a loss in the visual exploration (or which have a negative influence on visual exploration), in one or in both halves of the brain caused by injuries to the brain, lead to:

- impairments to filed of vision and
- visual neglect.

Impairments to the field of vision are responsible for the highest cases of sensory disturbances 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 an undamaged 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, according to definition, are incapable of reacting to stimuli which present themselves in a contra lateral 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, as they are incapable of registering any sort of a threat on this side. Patients with unilateral Neglect are also greatly restricted, because they, in the case of simultaneous Stimulation, both field of sight halves, are incapable of reacting to contra lateral Stimuli, when the ipsi-lateral is stimulated 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 hemianoptical 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 Aim of the training**

The saccadic eye movement training procedure was formed to help patients with deficits in Neglect, Hemianopsia or to help patients with general restrictions in their field of vision or in their visual efficiency.

The aim of the training is therapeutic treatment 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 deficits to their field of vision and visual neglect.

By using not verbal material, one can also work on restrictions in language and the patients comprehension of vocabulary.

It appears that the training can also be used with children from the age of 8 and up. With regard to the previous point more information has yet to be gathered.

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