HASOMED

# RehaCom®

## Cognitive therapy

# Visuo-Motor Coordination

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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).

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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.

# Table of contents

# 1 Description of the training

## 1.1 Training tasks

**Visuo motor co-ordination** is trained by using a coloured *rotor*, which glides across the screen in various complicated patterns of movement (Picture 1). On the screen there is also a smaller *cursor*, which the patient controls by using the RehaCom panel. The patient has to try to maintain as much contact as possible with the rotor as it glides across the screen.

The 'time outside' is measured, i.e. the total time in which the cursor is not in contact with the rotor. The measurement is calculated as a percentage, in relation to the **length of the task**. A task is considered as solved when the 'time outside' is less than or equal to the established minimum 'time outside'. A task is considered not to be solved when the 'time outside' is larger then the established maximum 'time outside'. If the time measured lies between these two previous values then the same pattern of movement is repeated. In this way the training process remains adaptive. In addition, the parameter **repetition** can also be set up to establish if a patient should advance to the next level. The error count is also registered as the number of the times the "Cursor was outside of the rotor" (cf. also Evaluation), however this is not used to evaluate a task.

As an alternative to the **abstract** rotor and cursor forms, a **concrete** form can also be used. In this situation, a beetle (=cursor) must be placed on a flower (=rotor). Picture 2 shows this very situation.  In this way, with various types of cursors and rotors a high level of motivation is achieved. Further examples are frog on a leaf, egg in a basket and mouse on the cheese.

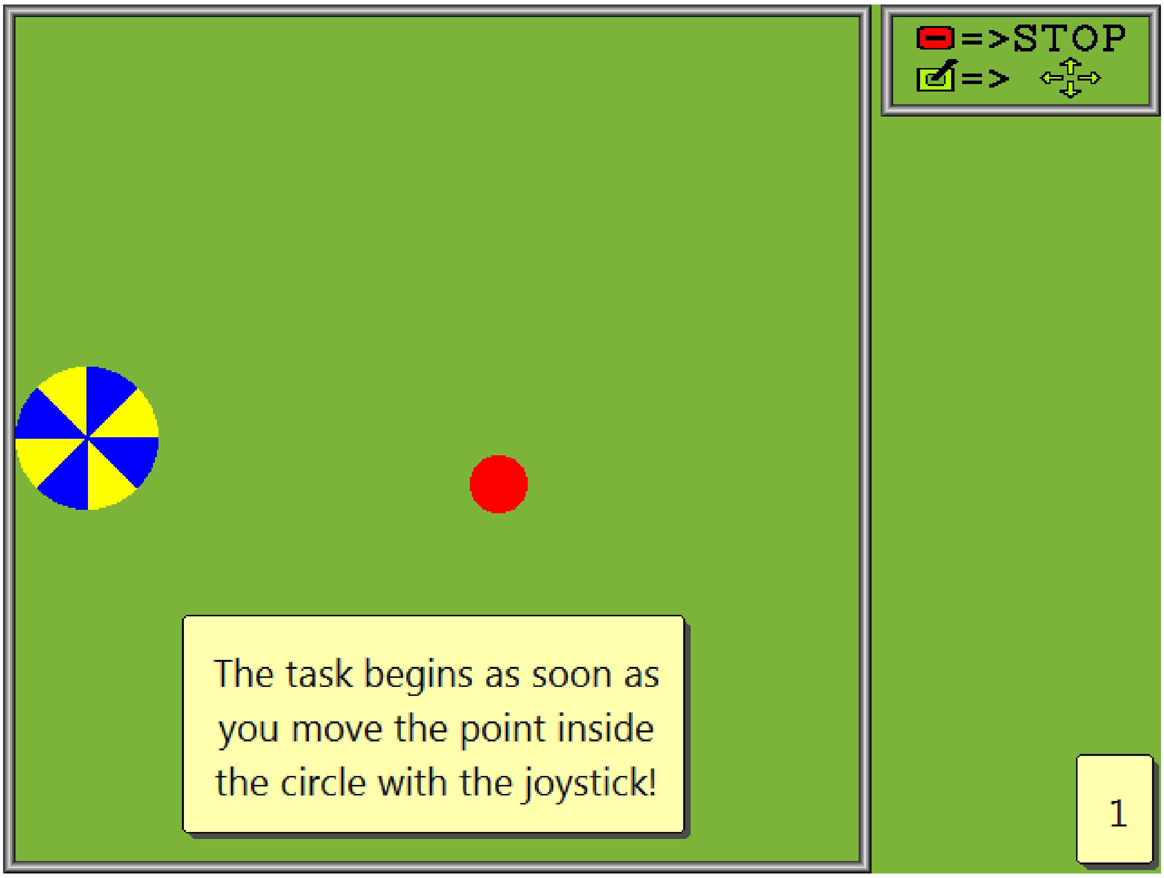


Fig. 1: Training of rotor type abstract.

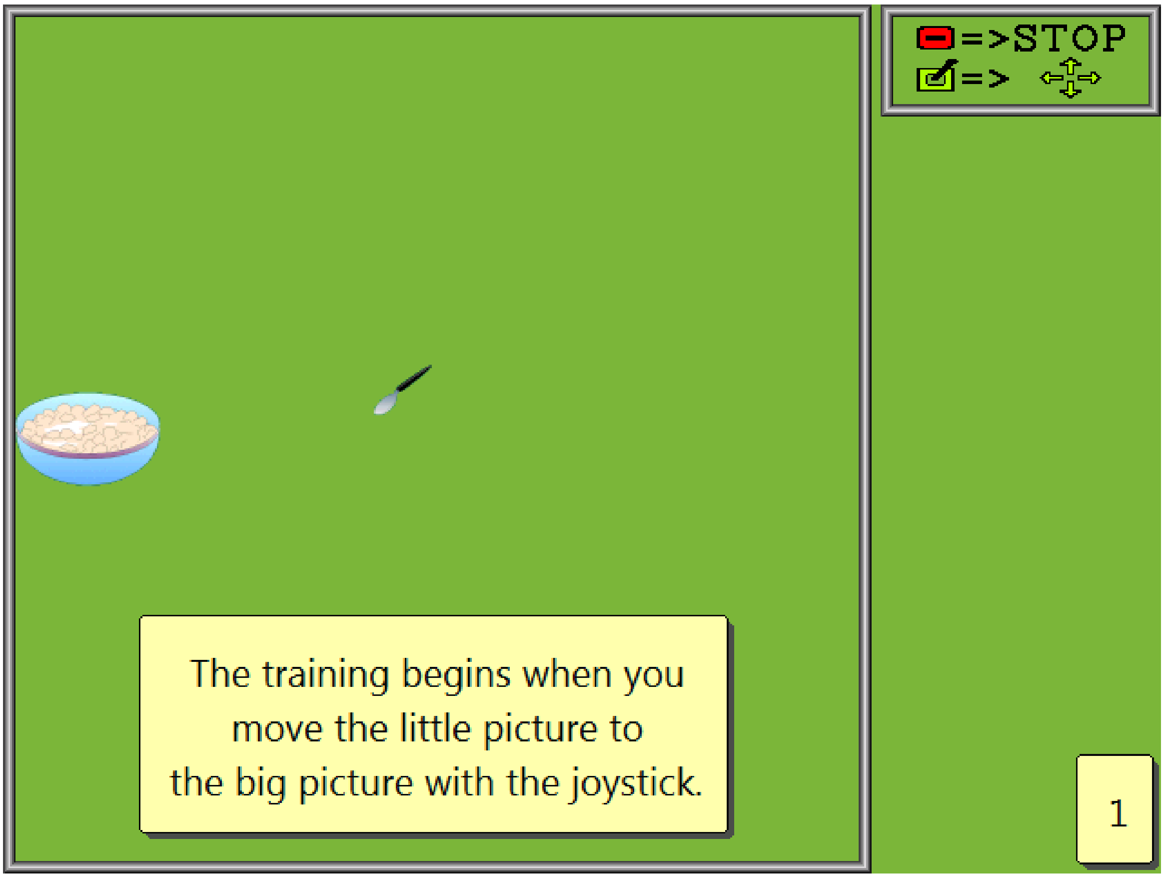


Fig. 2: Example of Rotor type concrete.

## 1.2 Performance feedback

When the acoustic feedback is activated, then a continuous error tone is generated every time a customer makes a mistake (cursor outside of the rotor). When the cursor is moved back within the rotor zone then the signal is deactivated. It is advisable to use this form of feedback at all times.

If there is more than one patient working in the room then this type of acoustic feedback could cause interference. In this case the visual feedback should be used. The rotor changes color to red if the cursor is outside the rotor zone.

After completing a task the patient is informed as to how they performed, the number of errors are then shown and the percentage of 'outside-time'. During the training the level can be seen on the bottom right hand side of the screen.

## 1.3 Structure of the level of difficulty

The nature of the rotors is the key to the levels of difficulty:

- The pattern of movement (32 different patterns of movement – see Picture 3),

- The size (3 rotor sizes – large, medium and small), and
- The speed (3 rotor speeds – slow, medium and fast).

The patterns of movement are divided into 5 sub groups:

- simple linear movement (patterns 1–2),
- combined linear movement (patterns 3–14),
- curved movement (patterns 15–24),
- combined curved and straight movements (patterns 25–31), and
- a pseudo stochastic movement (pattern 32).

In the last case, pattern 32, it is impossible to predict the nature of the movement.

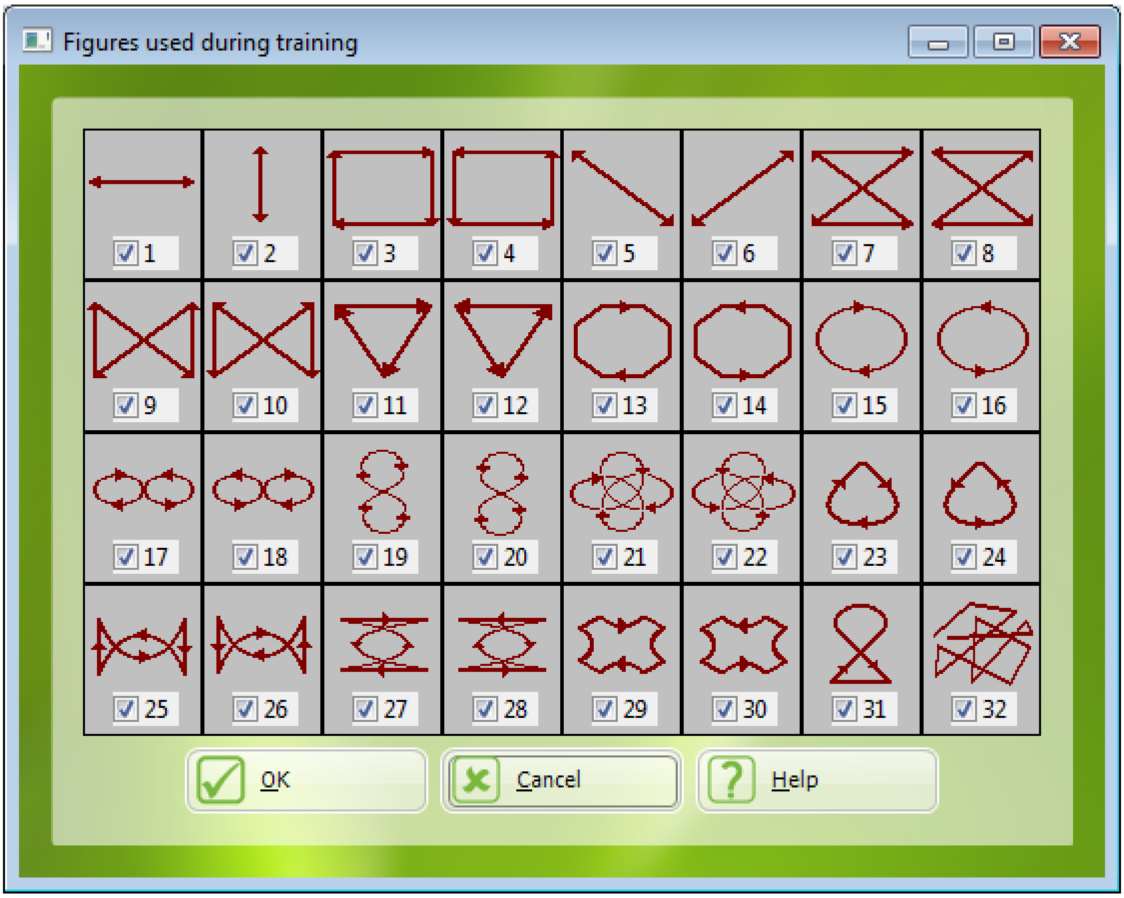

Fig. 3: Patterns of movement.

The patterns of movement are formulated in such a way as to facilitate an increasing complexity of movement with individual pattern number. The pattern numbers which have been marked are the ones which will be used in the module. If they are not marked then the patient will skip this pattern during the training. In this way, the patient can concentrate on certain movements while excluding others.

During the training the patient works through the patterns in sequence. When working with a particular pattern of movement, either the size or the rate of the rotor (speed) can be varied, in each case by 3 stages. One chooses the size or speed by using the control parameter. If the control parameter is set at speed, one can then choose the size of the rotor by selecting the parameter size, large, medium or small (stages 1–3). It will then remain the same at each individual task. If the control parameter is set to size, the speed can then be modified (stages 1–3 slow, medium and fast). In this way, target-orientated training is possible. The tasks are more difficultly when the speed is set at fast or the size set to small.

In order to alternate between the patterns of movement, the control modes *constant* and *sequential* are available. In mode *constant* each pattern is trained in 3 stages (slow, medium, fast or large, medium, small). After the patient has successfully completed pattern number 1, at all 3 stages, he continues working with pattern number 2. In mode *sequential*, at first, all the patterns in stage 1 should be trained. Only when the most difficult pattern in stage 1 is mastered, the patient can start to work on the patterns at stage 2.

The performance graphic at the end of training displays the level of difficulty in relation to the solved patterns. The maximum level of difficulty is 96 (32 patterns of movement * 3 possible variations (speed or size)).

## 1.4 Training parameters

In the Basic manual RehaCom general hints are given about the training parameters and their effects. These hints shall be taken into consideration in the following.

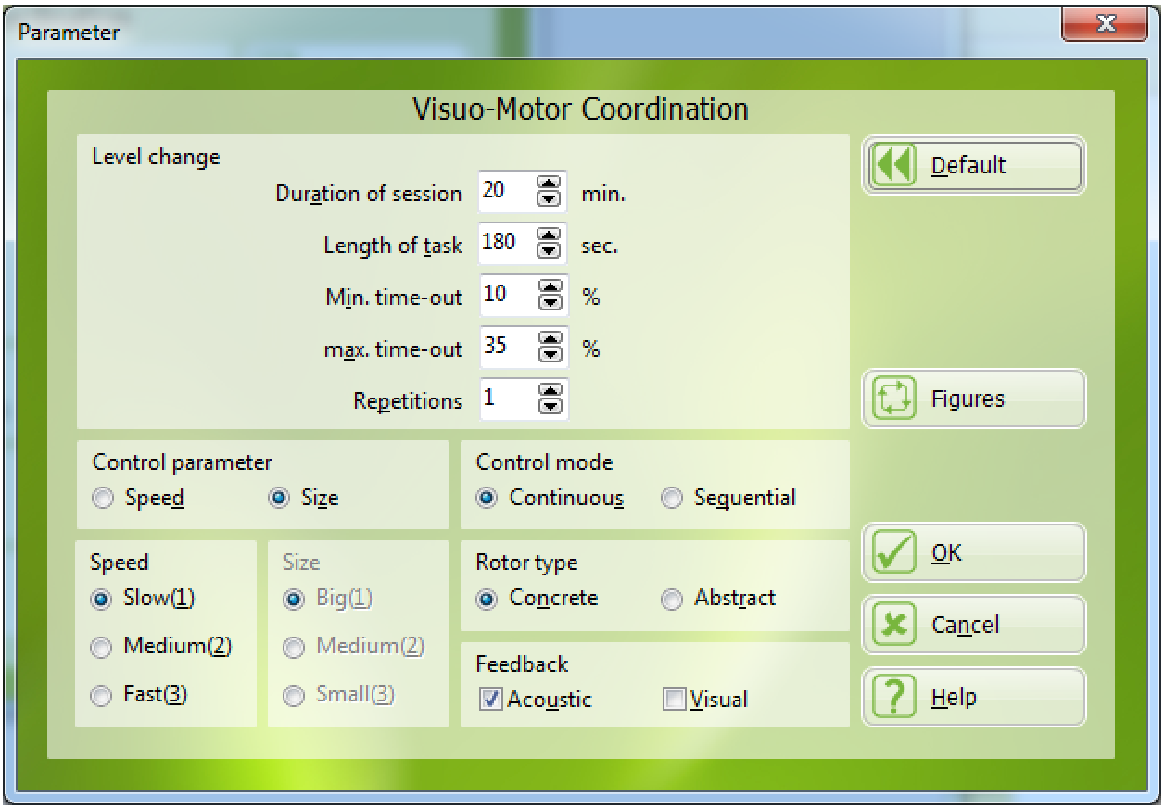

Fig. 4: parameter menu

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

***Length of task in seconds:***
The duration of the task should be clearly established (recommended 60–180 s). After this the task is ended and evaluated.

***Minimum and maximum time outside:***
See Training tasks.

***Repetition:***
The patient starts new task only if the current task was solved in accordance with established repetitions. The level of difficulty is reduced only when the can't solve a task in accordance with the number of repetitions. In this way the changing of levels is directly linked to the patient abilities.

***Control parameter, Size and Speed:***
See Structure of the level of difficulty.

***Control mode:***
See Structure of the level of difficulty.

***Rotor type:***

See Training tasks.

***Feedback:***
See performance feedback.

You are able to change the ***Side Orientation*** in the menu: Clients -> Edit -> Tab: File -> Options field: Hemianopsia.

With each new set up of the training the following defaults are automatically installed (standard level):

| | |
|---|---|
| Duration of training | 20 Minutes |
| Duration of task | 180 Seconds |
| Minimum time-out | 10 % |
| Maximum time-out | 35 % |
| Repetition | 1 |
| Rotor type | concrete |
| Control parameter | large |
| Tempo | slow |
| Control mode | constant |
| Feedback acoustic | on |
| Feedback visual | off |

## 1.5 Data analysis

The various possibilities of analyzing the data in order to find strategies how to continue the training are described in the Basic manual RehaCom.

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 |
| No. outside | Number of times the Cursor was outside the Rotor |
| Time-out | Time of Cursor outside of Rotor in [%] |
| Figure | Number of patterns of movement |
| Size | Rotor size |
| Speed | Rotor speed |
| Train. time task | Effective Training time in [h:mm:ss] |
| Breaks | Number of breaks caused by the patient |

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

# 2 Theoretical Concept

## 2.1 Basic foundations

Most human movement functions on the basis of **co-ordination** of several central **motor**, **visual** and **proprioceptive** systems. In the case of numerous activities, like the grabbing of objects, writing or playing a music instrument, an exact co-ordination of eyes, head and hands is required. During the act of moving (motor action), visual control has an essential role to play – in particular, when using tools and when learning new sequences of movement. *(performance of visuo-motor transformation cp*. Guedon et al., 1998).

***Learning to produce motion***
During voluntary movements, in particular with tool use, alongside fully functional motor skills, an intact visual system as well as an intact proprioception is necessary (cp. Guedon et al., 1998). The position of the hand and the target are probably represented as visual "cards", proprioceptive and motor "rooms", where visual and motor representations correspond to each other. (Bedford, 1994; cp. Guedon et al., 1998). If one of these systems experiences problems, motoric control can be compensated, up to a certain degree, by the other systems. (cp. Guedon et al., 1998).

In the case of the adaptive control of movements, the proprioceptive part is more important to perception, if one learns under disproportional feedback conditions, as for example, in the case of the distorted visual response through mirrors or prisms. The inconsistency between proprioceptive and visual information leads to a further *calibration* of the *visuo-manual* system.

What the motoric does is it to set up and/or maintain specific wanted perception constellations. A perception change can have an effect on the motor skills, just as a change in the environment can also have an affect: the clearest signals are a conglomerate from intrinsic and external signals.
By connecting the environmental motor stimuli and the continuous changes in perception the organism is able to perceptive copy of effect of his motoric. The organism can become familiar with the sensory consequences of its own motoric when it becomes active under poorly stimulated environmental conditions. These stimuli, as a rule, cause changes to the situation and position of limbs, which are registered – either in a direct sensory way, and which are acknowledged by the active organism – or else indirectly registered via use of a tool. When these sensory motoric connections are established, the organism can also then correctly register environmental changes, if he himself is motor active.
These learning processes can be described as the establishment of motoric programs or as control cycles. Motor learning could then be understood as a crossing over from regulation to control. (cp. Kalveram, 1981). The cerebral representation of the development of a spatial-temporal relationship of the act of carrying out movement, is however, not yet completely investigated. (cp. Guedon et al., 1998; cp. Mai, Blaut & Hermsdörfer, 1993).

***Tracking***

Sensory motoric control cycles are experimentally operational by means of so-called tracking-tasks, which have the following qualities (cp. Hammerton, 1981):

- An externally defaulted static or dynamic Input signal defines the motoric answer of the operator, which processes the task by initiation of visual and manual control processes
- These control mechanisms generate the Output-signal
- The difference between that output – and the input is the error value that should be held as possible from the operator

Processing these tasks requires a well matched visuo-motoric co-ordination. The predictability of the target of the INPUT signal is the most important factor for the tracking conversion. The degree of the connection between eye and hand system increases with decreasing predictability of the destination or with increasing target complexity. This result (Xia & Barnes, 1999) represents a common central sensory motoric control system of eye and hand, in the case of the tracking, which has also been suggested by other authors (Gauthier et al., 1988). On the other hand, Bock (1987, cp. Xia & Barnes, 1999) accepts the existence of parallel, independent channels.

***Visuo-manual System***

The eye and arm are subject to different physical and dynamic qualities and consequently, have different reaction times. Furthermore, eye movements and therefore the visual recording of movement changes, are to a small extent, voluntarily controllable and may have a considerably smaller degree of freedom than the arm. While hand movement is more of a progressive type of movement, eye movement is different during saccadic and slow movements (cp. von Cramon & Zihl, 1988). When it comes to spatial-temporal organization of motions, aspects of the cognitive organization and the range of automation should be taken into further considered (Philips, 1986):

- the execution of known motions after cognitive anticipation of the motions;
- what follows unknown motions and increased demands on the behaviourial reflex, and
- the execution of highly automatic patterns of movement as well as internal patterns of movement.

***The participation of other subsets in the system of visual-motoric co-ordination***

The adaptation of co-ordination requires an increased control over the attention processes. When it comes to the performance of visuo-motoric co-ordination, one can assume that the selective attention processes (Backs, 1997) is, during long durations of continuous acoustic activation, in a phase of an lasting attention performance. In the visual field  Posner has distinguished (1987; cf.Fimm, in 1997), with respect to the selective attention, three basic mechanisms, which occur after brain lesions, can also have selective damage:

- solved attention (disengage),
- postponed attention (move),
- focused attention (engage).

Due to the participation of numerous fields and structures of the brain, the attention system displays a special vulnerability after every cerebral insults and dysfunction.

Furthermore, the precondition for visuo-motoric performance is an intact *visual-spatial perception*, which, among other things, includes the correct estimation of positions, distances and angles (Kerkhoff, 1988, 1989).
These basic functions are highly relevant in everyday life. With spatial impairments, all practical activities can be seriously affected, which require one visual-spatial process or subsets of the spatial-constructive system.

***Impairments to the motoric system***
Impairmnets to the motoric system can occur within the framework of numerous cerebral and peripheral injuries.

As a result of an injury to the motoric cortex, central paralysis can occur in the contra-lateral half of the body. Impairments in the basal ganglion, as in the case of Humtington's chorea and morbus Parkinson, have multiple negative consequences. Impairments to the okculomotor (which can also affect the visuo-motoric co-ordination) occur within the framework of numerous neologic illnesses; in particular as result of injuries to the brain stem.

One can also observe disturbances to spatial and temporal co-ordination of the movements of extremities, as in the case of **apraxia**, which Liepmann distinguished as (1905, 1908; cf.Goldenberg, 1993) ideo-motoric (incorrect imitation of gestures) and idea-toric (involuntary movement and loss of memory i.e. for the correct use of an object) apraxia. These impairments affect, in a selective manner, the planning or carrying out of motoric actions and always, in the case of unilateral lesions, the ipsilateral side the body - in relation to the lesion.

After patients have been treated in a rehabilitation clinic, they often complain of impairments to their concentration and attention. Alongside these impairments patients also complain of disturbances to their hand movement, in particular when carrying out detailed work. The deficits can affect different aspects of motoric ability, for example, the sensitivity with regard to different modalities, finger mobility, physical strength or co-ordination. The scale of the impairments can vary significantly. Some patients the lack of mobility in the hands during every day activities, others only notice it when carrying out a complicated action with the hands, for example, playing a musical instrument. Impairments to movement in the hands can only be characterized after a detailed description of these disturbances on several levels (for a full representation, see Mai et al., 1993). For a detailed diagnostic of sensory motoric impairments, see the diagnostic from Schoppe (1974; cp. Mai et al., 1993), Platz (1992), Weber (1992) and Behremburg (1992).

## 2.2 Aim of the training

The aim of the training is to improve the patient's visuo-motoric co-ordination. In addition the training also helps to improve the patient's level of attention and reaction time.

The training works on the basis of the so-called Tracking task. The patient has to follow a given movement (a set of lines or the movement of a pointer) on the screen by using a control panel (joystick, control dial).

The level of difficulty is established:

- through the training tasks themselves, whereby motions always re-occur (the learning the processes encourages the anticipation of the individual patterns of movement),
- through tasks with increasing demands on the patient's reaction ability (having to follow previously unseen pattern of movement) and
- through stochastic movements, interruptions and reversals within a given time.

One can expect that an improvement in the visuo-motoric co-ordination will have a positive affect in the ADL field (Activities of Daily Living), as motoric disorders cause daily hindrances (eating, getting dressed, body care, writing, drawing, driving).

On the premise of maximum specificity of therapy, one should always precede the training with a differentiated disorder specific neuropsychological diagnostic (cf. Basic foundations).

Although the diagnostic protects the deficit because of the complexity of the function and therefore a precise training is complicated, which results in unsystematic practicing of precise training finger-hand-arm movements.

The following RehaCom modules are recommended as a support to this module: **Spatial operations** (RAUM), **Visuo-constructive abilities**(KONS), and **Two-dimensional operations** (VRO1).

## 2.3 Target groups

This module is recommended for training the visuo-motoric co-ordination skills of patients with impairments to their hand control /functions and visual spatial perception. It is also recommended for patients who have problems with spatial construction.

Defective control / functions in the hand as well as disorders in visuo-motoric co-ordination often happen as a result of injuries to the organic brain, e.g.as in the case of cerebral insults, infarcts, hemorrhages, tumours or brain trauma. However they are also known to occur after diffuse injuries to the brain. Patients suffer mostly from *paralysis, disorders in their bodily sensations (awareness of the body) or with atactic disorders in motion*. This is often the case if a patient is suffering from pyramidial disorder or after a cerebral injury. A broad spectrum of motoric disorders occur as a result of injuries/diseases to the brain, e.g. chorea Huntington, Morbus Parkinson, multiple sclerosis or as a result of cerebral system atrophy. The following can also have a negative affect on the visuo-motoric co-ordination: deficits in the elementary sight functions, disorders in the Oculomotoric, disorders to the visual-spatial functions, apraxia and serious attention disorders. Disorders to the visual-spatial functions and/or a dysfuntional proprioception have negative affects on the adaptive mechanisms of the continuous movement control and correction.

As a result of complex disorders to the visual-spatial deficits, patients who suffer from brain damage are primarily affected due to posterior and/or partial-occipital uni- and bilateral lesions or injuries, which in turn damage the visual system.

In particular, right-hand parietal lesions cause visual-spatial disorders or in very rare cases visual neglect itself. Patients who suffer from Hemiplegie, which affects the dominant hand, could also improve the mobility of their other hand by training with the module **visuo-motoric co-ordination**.

The training should be started as soon as the first signs of such disorders.
The module can be used with children from 8 and up. Up to the age of 14, appropriate instructions for children should be used. It is also possible to use the training to the help with disorders in attention.

If the patient suffers from extreme disorders to motoric functions (e.g. Ataxia), whereby the patient is not capable of using the controls; then this type of training is not recommended.

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# Index

## - A -



## - B -



## - C -



## - D -



## - E -



## - F -



## - G -



## - H -



## - I -



## - L -



## - M -



## - N -



## - O -

# - P -



# - R -



# - S -



# - T -



# - V -