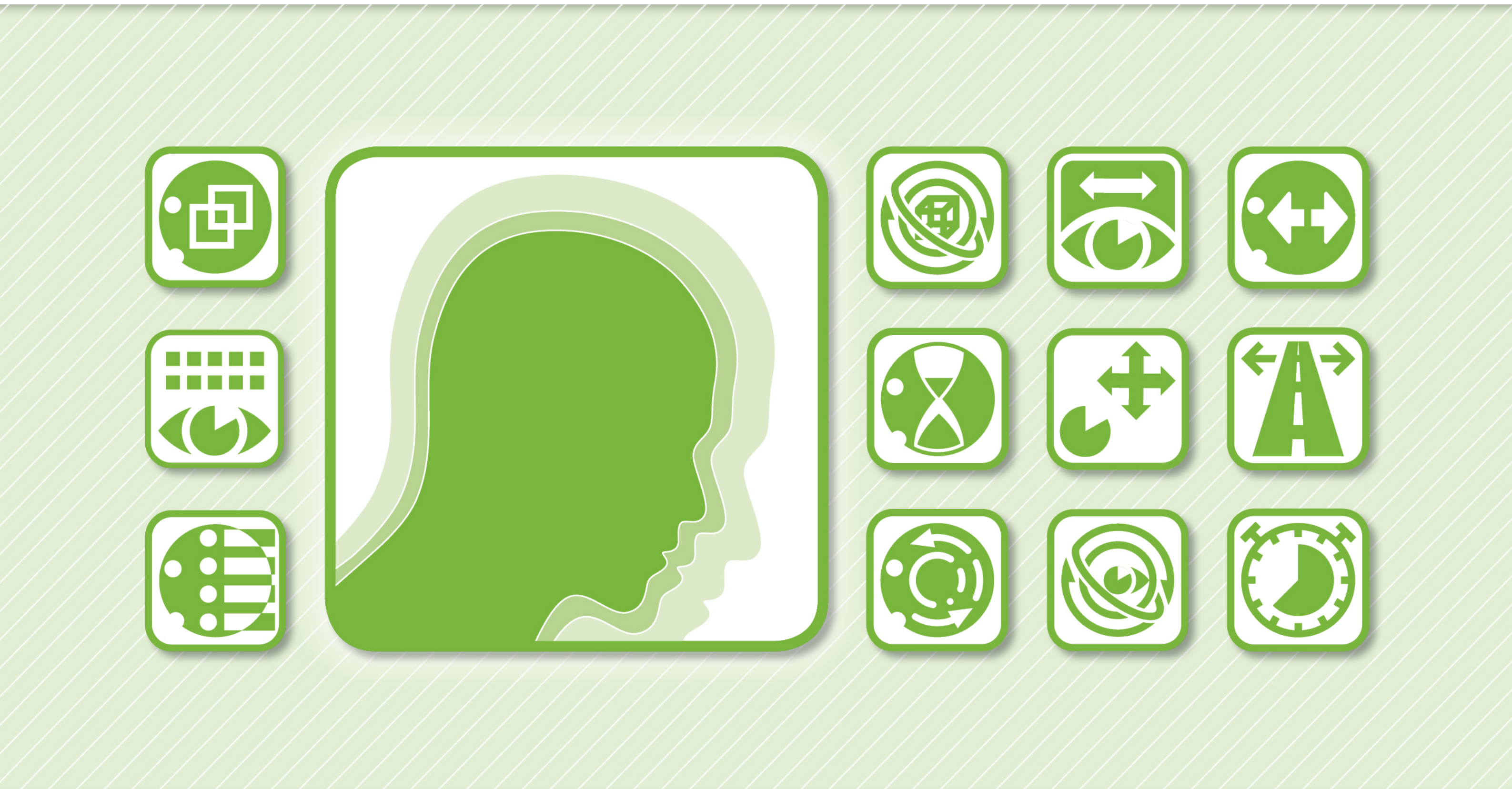
HASOMED

RehaCom®

Cognitive therapy



Two-dimensional Operations

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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.

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1 Training description

1.1 Training task

The module **Two-Dimensional Operations** is used to train a patient's visual spatial operation, particularly the ability for mental rotation.

On the computer screen (see Fig. 1), one can see a selection of different objects which have been placed in a matrix (3, 6, 9). A separate individual picture can also be seen on the side of the screen. Only one of the pictures in the matrix is identical with the separate picture. It's the patient's task to locate and select this picture from the matrix. However, the picture in the matrix, which has to be matched with the separate individual picture has been rotated. In order to make the correct selection, the patient has to exercise his or her ability for mental rotation of two-dimensional objects.

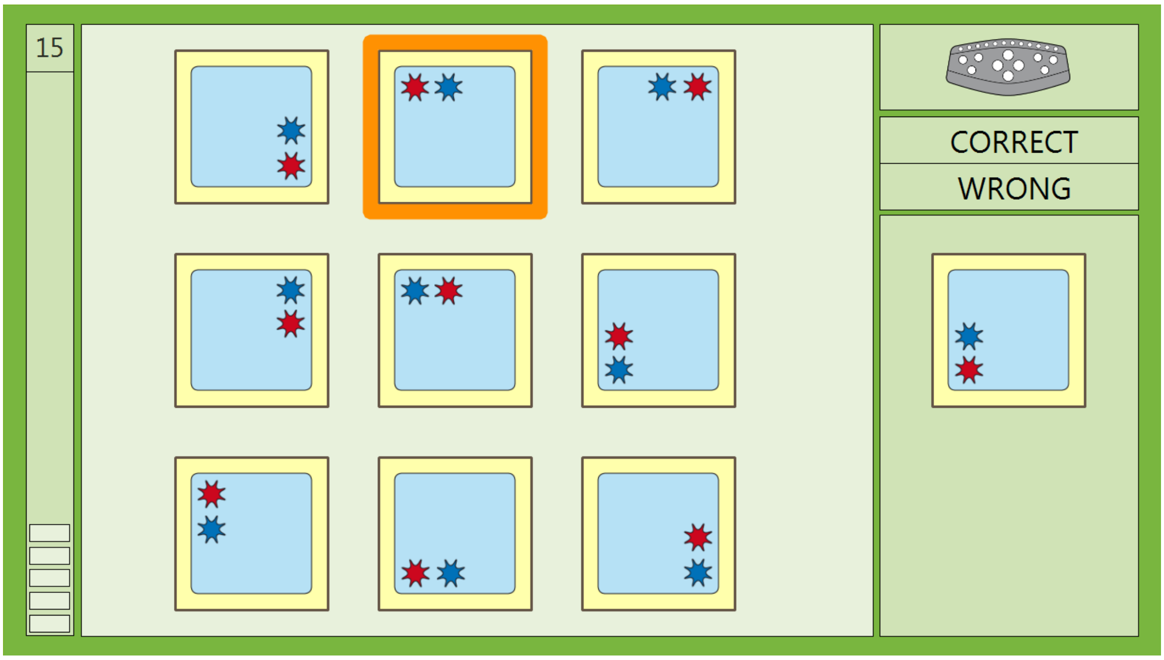

Fig. 1: Training at level 15 - a matrix of 3 X 3 pictures. The selected picture has been marked.

The patient can select the matching picture from the matrix by using the RehaCom Keyboard, the mouse, or the touch screen.

The large arrow buttons of the RehaCom Keyboard are used to move an orange frame from picture to picture in the matrix. In order to mark the selected picture, the **OK** button must be pressed. This facility is offered for patients with visuo-motor coordination problems, tremors, and other such problems with hand movement. The large buttons can, if necessary, be operated by foot. This is to facilitate training for the handicap.

A very comfortable method of operation is with the mouse. An arrow is moved across the screen. If the arrow is over a picture, an orange frame appears around the picture. In order to confirm the selection, the patient simply presses the space bar. As an alternative, more dextrous patients can confirm their selection by using the mouse key. Visuo-motor abilities are trained in addition to the aim of the module.

The simplest form of interaction is using the touch screen method. The patient touches a picture, and an orange frame appears. As long as the patient is still touching the screen, the frame can be moved from picture to picture. When the patient removes their finger from the screen then that picture is selected. This is the recommended form of training for children.

Another input option is the One button operation: One picture will be selected automatically. It will be changed after a specific period of time, so the frame will move to the next picture. When the **OK** button on the keyboard is pressed, the currently selected picture will be confirmed and evaluated. This alternative is especially recommended for patients with motor problems.

1.2 Performance feedback

After the patient has chosen a picture, the module evaluates the decision:

- The green field "Correct" and/or the red field"Incorrect" is highlighted.
- A performance bar (in Fig. 1 left) increases with correct decisions and decreases with incorrect decisions.
- When the acoustic feedback is enabled, a tone can be heard when an incorrect answer is selected.

If the performance bar reaches it maximum point, the task is ended. Similarly, if the patient makes a lot of errors and the scale reaches its minimum, the task is also ended. A performance assessment is then shown. The next or the previous level of difficulty is then set up , depending on the assessment of the performance (successful - continue to the next level, unsuccessful -repeat the previous level) If the repetition mode is set to any value other than 0, then the patient must repeat the level of difficulty until he or she consistently completes the task the number of times designated by the repetition parameter.

The number above the performance bar shows the current level of difficulty.

1.3 Levels of difficulty

The level of difficulty adjusts adaptively. Table one shows the description of the task at each level of difficulty.
There are 8 stages of difficulty with 80 to 160 pictures, which vary from very simple objects to complex groups of objects.

By means of a study, we were able to allocate the correct series of pictures to each individual level. This was achieved by measuring the average time taken coupled with the number of mistakes made by the sample group. This also helped us establish the criteria for the levels of difficulty. At higher levels of difficulty, there is deliberate use of occasionally easier series of pictures to maintain the patient's motivation.

Each stage has 3 levels of increasing difficulty based on the size of the matrix (e.g., matrix containing 3, 6, or 9 pictures). The ability to compare position, length, size, angle, distance, amount and pattern, by means of mental rotation, is developed by the module. The tasks with 3 pictures are naturally considerably easier than those with 6 or 9.

Level	Matrix	Stages of difficulty
1	3	Simple pattern, length, position and size comparison with minor demands on mental rotation.
2	6	Simple pattern, length, position and size comparison with minor demands on mental rotation.
3	9	Simple pattern, length, position and size comparison with minor demands on mental rotation.
4	3	Additional comparison of distance and angle with minor demands on mental rotation.
5	6	Additional comparison of distance and angle with minor demands on mental rotation.
6	9	Additional comparison of distance and angle with minor demands on mental rotation.
7	3	Objects rotated in 90° steps 2 elements per object must be taken into consideration. Mental rotation is required.
8	6	Objects rotated in 90° steps 2 elements per object must be taken into consideration. Mental rotation is required.
9	9	Objects rotated in 90° steps 2 elements per object must be taken into consideration. Mental rotation is required.
10	3	Any type of rotation. 2 elements to be taken into consideration.
11	6	Any type of rotation. 2 elements to be taken into consideration.
12	9	Any type of rotation. 2 elements to be taken into consideration.
13	3	Rotation 90°. 3 elements to be considered.
14	6	Rotation 90°. 3 elements to be considered.
15	9	Rotation 90°. 3 elements to be considered.
16	3	Any type of rotation. 3 elements to be considered.
17	6	Any type of rotation. 3 elements to be considered.
18	9	Any type of rotation. 3 elements to be considered.
19	3	Rotation 90°. >3 elements to be considered.

20	6	Rotation 90°. >3 elements to be considered.
21	9	Rotation 90°. >3 elements to be considered.
22	3	Any type of rotation. >3 elements to be considered.
23	6	Any type of rotation. >3 elements to be considered.
24	9	Any type of rotation. >3 elements to be considered.

Tab. 1: Level of difficulty

1.4 Training parameters

Specific settings for the training module can be adjusted (see Fig. 2). This section describes each setting and explains how to adjust them.

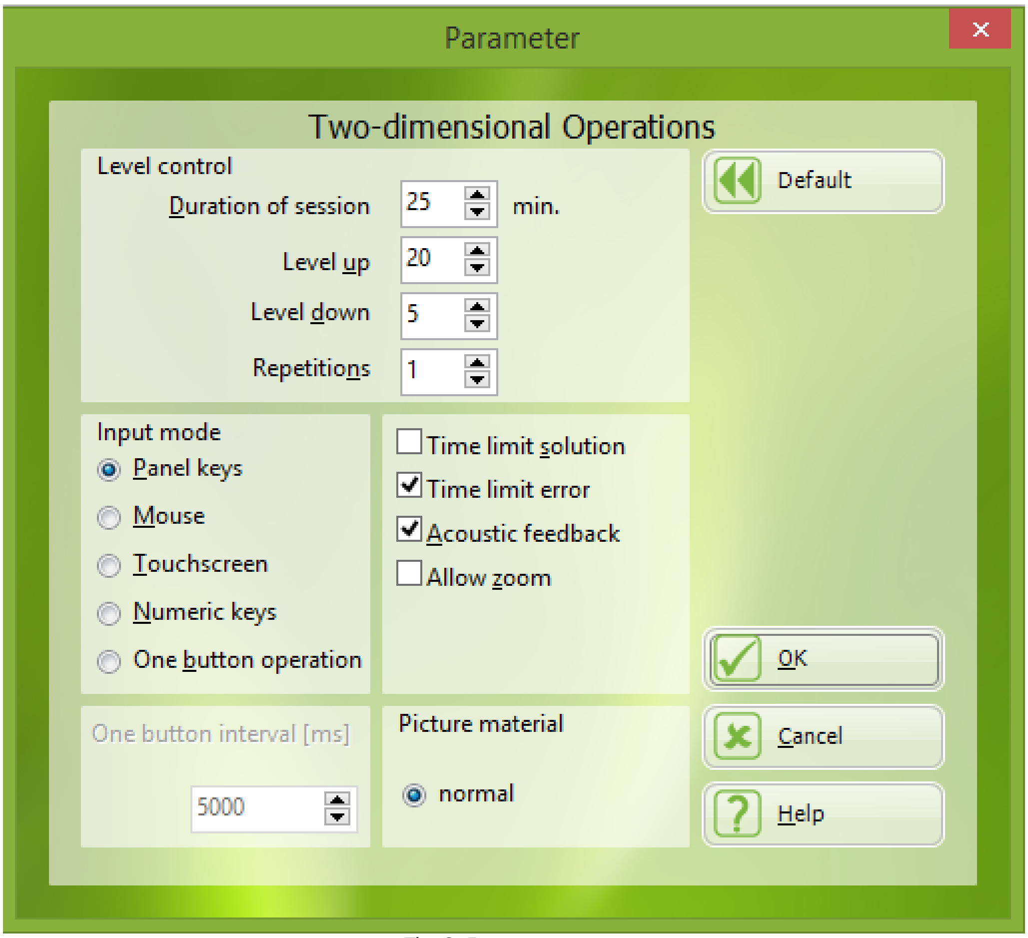

Fig. 2: Parameter menu

Duration of session in min:
A training time of 20 to 30 minutes is recommended.

Level up:
To reach the next higher level, the number of correct answers must exceed the number of incorrect answers by the number in the ***Level up*** setting. Incorrect

decisions will reduce the performance bar on the left side of the screen while correct answers increase it. The next level begins when the performance bar reaches its maximum.

The levels can progress more quickly if no errors are made. If the patient makes no mistakes on the items in a level, the next level can be reached once half of the correct answers are made. For example, if the default value for ***Level up*** is used (20), and the patient makes no errors on the first 10 items, the next level will begin. Nevertheless, the aspects of the parameter option ***Repetitions*** should also be taken in to consideration.

Level down:
The next lower level starts when the number of items solved incorrectly in succession is equal to the number in ***Level down***, or if the performance bar reaches its bottom. The aspects of the parameter option ***Repetitions*** should also be taken in to consideration.

Repetitions:
The level changes if the number of tasks is consistently solved either successfully or not. The level will only changed once the patient shows consistent performance on a level of difficulty. If the ***Repetition*** parameter is set to 0, the level changes after each task is solved.

Input mode:
The various ways of operating the module (RehaCom Keyboard, mouse, or touch screen) have been described in the section Training tasks.

Time limit solution:
When enabled, the patient only has a limited time to solve a task. This time is dependent on the level of difficulty and is set at a minute for the easiest task in level 1. This time advances by 5 seconds per difficulty stage, and consequently, reaches approx. 3 minutes at the highest level of difficulty. When this parameter is disabled, then the patient has unlimited time to solve a task.

Time limit error display:
After choosing a picture the patient receives feedback, either "Correct“ or "Incorrect.“ When the patient chooses correctly, the correct picture is framed by an orange frame, and a "Correct" notification stays on the screen for 3 seconds. This can be shortened by pressing the **OK** button. When the patient chooses incorrectly, the "Incorrect" picture has a red frame. If the parameter ***Time limit error display*** is disabled, he or she can compare the pictures without time limit and find the differences. The next item appears only after the patient has pressed the **OK** button. When the parameter ***Time limit error display*** is enabled, then the patient only has ten seconds to compare the pictures. After that time, a new item is shown. Therefore, it is a bit more difficult to solve a task.

Acoustic feedback:

When the parameter ***acoustic feedback*** is enabled, a typical error tone can be heard if the patient makes an incorrect decision. If there is more than one person training in the room, this feature may cause interference. In this case, the acoustic feedback should be deactivated or head phones could be used.

Allow zoom
This option is especially important for patients in an early rehabilitation phase and for patients with visual field problems.
When ***Allow zoom*** is enabled, the patient can increase the size of the currently selected picture and the example picture together for easier comparison.
Pressing the **plus (+)** button will enlarge the picture in the orange frame and the example picture and set them side by side for comparison.
While the images are enlarged, pressing any button on the RehaCom Keyboard (including the **plus** button again) will reduce their size and separate them.

One button interval:
The ***One button interval*** is a time delay setting used along with the ***One button operation*** input mode. The ***One button interval*** sets the amount of time until the next picture is selected. When the ***One button operation*** input mode is selected, the selection frame moves from one picture to the next at the rate set by the ***One button interval*** parameter.

When starting this training for a patient for the first time, the system automatically uses the following default values:

Current level of difficulty	1
Duration of session	25 minutes
Level up	20
Level down	5
Repetitions	1
Input mode	Keys
Time limit solution	Disabled
Time limit error display	Enabled
Acoustic feedback	Enabled
Allow zoom	Disabled
One button interval	5000 (milliseconds [ms])
Picture material	normal

Tab. 2: Default parameters

Neglect/Orientation:
An additional setting that is not found in the parameter menu is for patients with neglect or hemianopsia. You can establish this setting in the Clients menu: Clients --> Edit --> File tab --> Hemianopsia. By selecting either left or right in this field, additional assistance will be provided in the training module.
When a setting for neglect or hemianopsia is selected, a blinking red arrow helps the

patient to find the example picture to compare to. A red bar on screen border gives a clue where the screen ends. The patient can be instructed to look for the correct image "until the red bar is found."

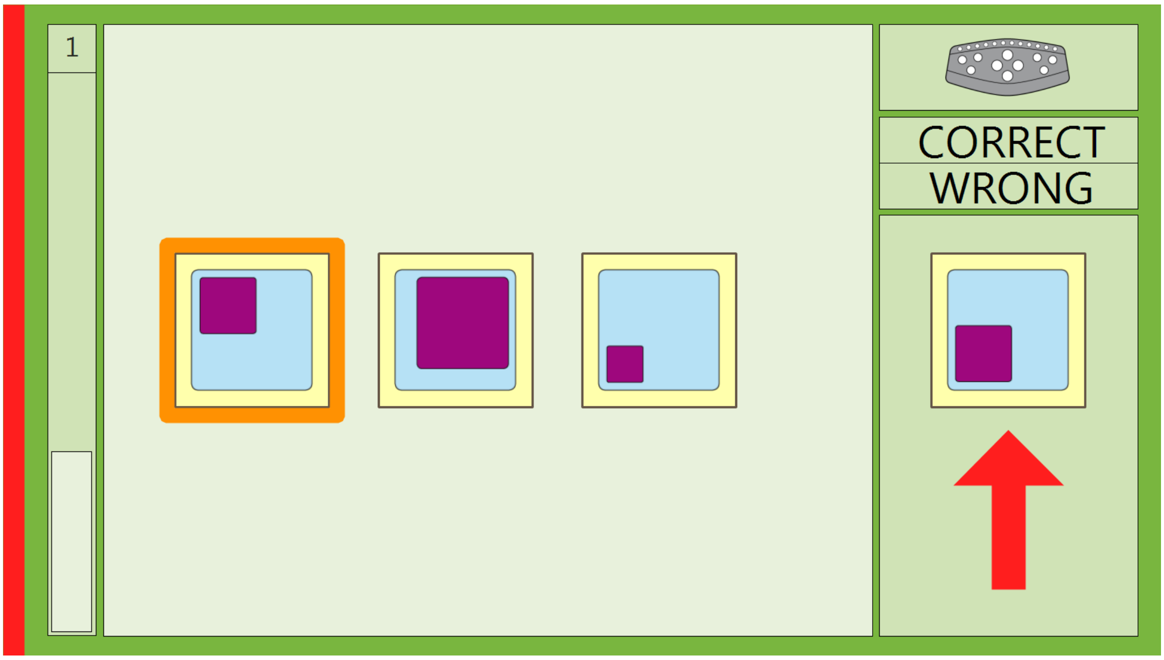

Fig. 3: Training w ith enabled side orientation
(red bar and arrow are added)

1.5 Data analysis

All training sessions are placed in a chart within the Results tab. 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
Decisions	Number of solved tasks
Mistakes	Number of incorrect decisions
Omissions	Number of errors due to exceeding the given time (only when the parameter ***Time limit solution*** is enabled)

The reaction time is calculated as the time from the appearance of the matrix to the selection of the **OK** button

Min. react. time	Min. reaction time in [s]
Max. react. time	Max. reaction time in [s]
Quartil 1	Reaction time quartile 1 in [s]

react. time	
Median react. time	Median of all reaction times in [s]
Quartil 3 react. time	Reaction time quartile 3 in [s]
Median react. time left	Median of reaction times for left images in [s]
Median react. time center	Median of reaction times for center images in [s]
Median react. time right	Median of reaction times for right images in [s]
Train. time	Effective training time in [h:mm:ss]
Breaks	Number of pauses by the patient

Tab. 3: Results

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

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

2 Theoretical concept

2.1 Foundations

Visual spatial performance is defined as perception abilities which require a visual comparison of spatial stimulus without manual effort from the patient. In contrast to this, spatial-constructive performance demands the exact manual-constructive component to be under visual control (Kerkhoff, Münßinger & Marquardt, 1993). The precondition for visual-constructive performance is an intact spatial-operation perception.

The visual-spatial perception is a component of elementary visual efficiency and consists of the following basic functions (Kerkhoff, 1988):

Visual spatial perceptive performance

- Estimation of the subjective visual vertical line or subjective visual horizontal line
- Estimation of length
- Estimation of distances
- Halving of lines
- Estimation of angles
- Estimation of positions
- Estimation of shapes

Visual spatial operation

- Mental rotation
- Transformation performance (measure, angle, size transformations, tasks with varied spatial systems)

In contrast to the visual spatial perceptive performance, visual spatial operations require cognitive services in the form of an intermediate step separate from the stimulus material.

Basic functions of the visual spatial perception are of great relevance in everyday life, particularly in traffic. From following a straight line while walking to fine motor adjustment while reading (which are dependent on the elementary aspect of visual performance), spatial disturbances can affect all practical everyday activities which require a visual spatial operation or a partial spatial-constructive performance. Patients with technical professions who suffer from these deficits will often lose their positions and therefore are clearly more affected than others.

Several studies (von Cramon & Zihl, 1988; Kerkhoff & Marquardt, 1995) showed a statistical connection between visual-constructive and visual-spatial problems and impaired activities of daily living (ADL) where a causal relationship was discussed. This is not surprising when where there is dependency on an intact visual-spatial perception and/or spatial-constructive subsets of the system and numerous activities of daily life:

- Dressing
- Folding of laundry
- Estimating and separating amounts
- Decorating a table
- Tidying
- Grabbing objects
- Estimating the depth of steps/stairs
- Reading plans or sketches
- Filling in forms and documents
- Maintaining lines and columns while drawing
- Finding one's way
- Navigating a wheel chair

More complex disturbances to perception are often a result of disturbances to elementary visual tasks, such as depth perception. Loss of depth of vision means that everything appears to be flat (e.g., dice appear to be six cornered objects). The trouble with disturbances to depth of vision is that it is sometimes combined with changes in the perception of the sizes of objects (Micropsia and Macropsia), however, it can also affect the appearance of objects and faces. The latter is also to be seen in the case of cerebral amblyopia, problems with shape and color perception which occurs in most cases after post-chiasmatic injuries.

Impaired visual localization of stimulus affects the appraisal of distances. The patient then overestimates or underestimates distances.

Impairments of the appraisal of the main visual spatial directions leads, in most cases, to a shift of the subjective vertical, horizontal, and straight directions. In the case of unilateral lesions, vertical and straight line direction perception is normally shifted to the side opposite the area of brain damage - the horizontal perception is mostly displaced equally to the vertical axis. (von Cramon, 1988).

Visual spatial orientation problems express themselves in the loss of the spatial organization of a pattern of stimuli. This loss is often coupled with difficulties in measuring through impairments in the recognition or localization of spatial positions and regions as well as the ability for spatial imagination.

Visual spatial perception deficits are often correlated with visual-constructive impairments in a cause-effect relationship (von Cramon, 1988).

Spatial-constructive problems, or constructive apraxia, refer to the inability or decreased ability in patients with a brain injury to draw two-dimensional or three-dimensional shapes and figures correctly and/or to join elements of a figure together to form a total figure.

While processing such tasks, length and angular distortions, changes in size or the erroneous ordering of individual elements of a total figure can occur, which are also sometimes reconstructed in a completely fragmented manner.

Also independent constructive performances like the drawing of a spatial series, for example a room is no longer possible with the above described/defined deficits.

A personal medical history of complaints is only useful for patients without visual neglect, anosognosia, or anosodiaphoria. For the patient group with reduced insight, Kerkhoff & Blaut (1992; Kerkhoff, et al., 1993) have developed an external clinical history form. To diagnose performance in visual-spatial perception, the following tests, such as line orientation, line halving, spatial sub tests in intelligence tests or the computer-assisted procedure, are suitable (Kerkhoff, et al., 1993). The latter registers elementary performances of the visual spatial perception in contrast to all other procedures. The tests for visual object and spatial perceptions (VOSP; Warrington & James, 1992) also tests for problems with basic visual functions which often occur together with constructive apraxia and are possibly the cause. To diagnose spatial-constructive problems, the free copying of geometric or other patterns, the copying of perspective drawings, or the drawing test according to Grossmann (1988) are suitable. The Block Design or Picture Completion subtests from the Wechsler Adult Intelligence Scales–Revised (WAIS-IV, Wechsler, 2008), the Benton Test (Benton, 1981) or the Rey-Osterrieth-Figure (Osterrieth, 1944) are also suitable as diagnostic instruments.

2.2 Training aim

The aim of the module **Two-Dimensional Operations** is the training of spatial operations, in particular the mental rotation of two-dimensional objects. These cognitive transformation performances require basic visual-spatial abilities.

After improvements in basic visual-spatial functions, therapeutic benefits in relation to more complex problems can be expected, such as improvements to visuo-constructive abilities, because these deficits are more likely caused by impairments in basic visual perception.

It is to be expected that the training has a favorable effect on the Activities of Daily Living (ADL), because problems with spatial perception and spatial operations hinder numerous practical activities, especially if these activities depend on a precise visual-motor coordination.

Under the premise of maximum specificity of therapy, one should always start with a differentiated problem-specific neuropsychological diagnostic (for specific tests, see Foundations).

For additional training, the RehaCom module **Spatial Operations** (RAUM) can be used to treat this complex type of disturbance. The training module **Two-**

Dimensional Operations can also be used as a cognitive type of training for attention deficits. In this case, the module **Attention and Concentration** (AUFM) can be used. The **Attention and Concentration** module does not contain the aspect of spatial rotation, but the training module is constructed in a similar way.

2.3 Target groups

The module Two-dimentional operation is recommended for patients who suffer from impairments to their visual spatial perception and their spatial construction ability. Patients who are mostly affected are those whose brain has been damaged after posterior and/or parietal-occipital uni- and bilateral lesions or injuries to the visual system. In particular, visual-spatial problems often occur after right-side parietal lesions.

The visual-spatial functions can be affected by various injuries to the brain (insult, hypoxia, TBI, tumors). Other patients who will also benefit from this training are patients with visuo-constructive problems, visual neglect, field of vision problems, and patients with impairments to their objective perception due to deficits in their elementary visual capabilities.

For patients with right hemispheric injuries to the brain, there is a clear indication of a covariance between impairments to the visual spatial perception and visual construction problems (Kerkhoff, 1988). Also after right and left hemispheric posterior lesions, a decreased ability has been found for mental rotation, which impairs the visual construction performance.

In addition to hemiplegia, visual-construction and visual-spatial problems are the most important predictor for the rehabilitation process in patients with injuries to the right hemisphere of the brain(see Foundations). It was repeatedly found that, for patients with left hemispheric hemiplegia, the rehabilitation process is unfavorable for deficits of visual perception (Kerkhoff, 1988).

The module can be used with children ages 10 years and older provided they do not have any development delays or disorders. It is recommended that a therapist is present during the early stages of training. From a diagnostic point of view, it is recommended that individuals with serious intelligence deficits be excluded from the training process.

Friedl-Francesconi (1995) tested patients suffering from dementia with several of the RehaCom modules, including **Two-Dimensional Operations**. They achieved improvements in memory and attention functions. In an additional efficiency study (Friedl-Francesconi, 1996) on trauma patients using **Two-Dimensional Operations**, there were improvements in the visual short-term memory and in the visual spatial capability.

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