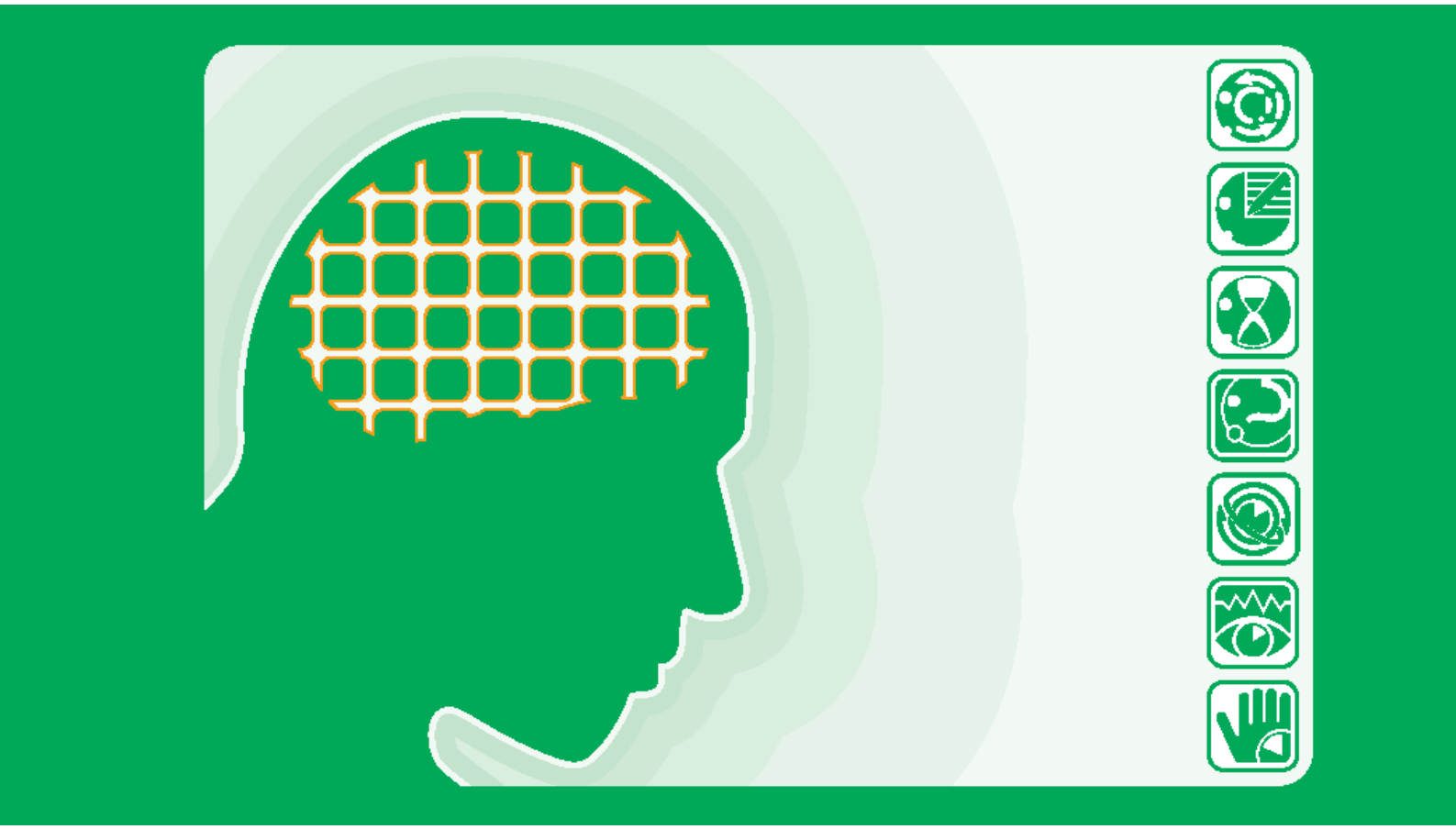
RehaCom

computer-assisted cognitive rehabilitation - brain performance training



Topological memory

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HASOMED®

Hard- und Software für die Medizin

RehaCom®

computer-assisted cognitive rehabilitation

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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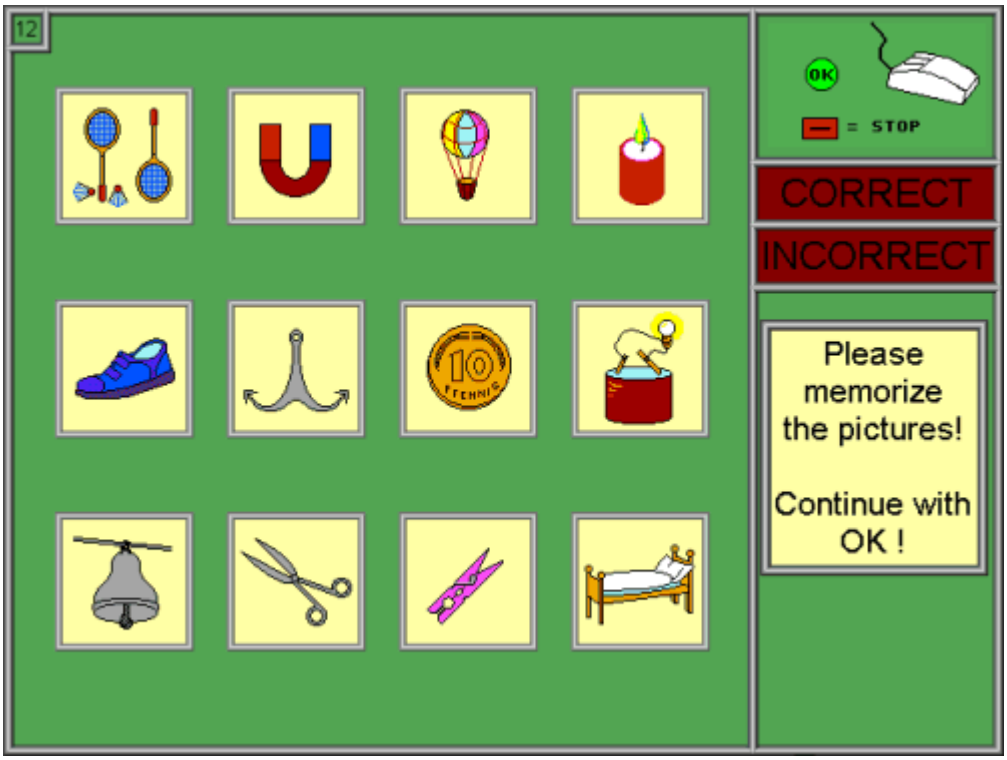
1 Training description

1.1 Training task

When we refer to the training procedure, topological memory, every training task is divided into two stages:

- the **acquisition** stage and
- thereafter the **reproduction** stage.

In the acquisition stage (picture 1), pictures (subjects, figures, symbols) appear on the monitor in a matrix with 3, 4, 5, 6, 7, 8, 9, 10, 12, 14 or 16 objects (see structure of the level of difficulty). The patient's task is to memorise contents and place of these pictures. The patient ends the acquisition stage by pressing the OK key.



Picture 1. Acquisition phase at a difficulty level of 12.

Then follows, the **reproduction phase** (picture 2). The pictures are now "covered". One of the covered pictures is then presented separately, (without cover). The patient's task is to locate the picture's pair from the matrix of covered pictures.

Different input modes are possible for the selection of the missing pair

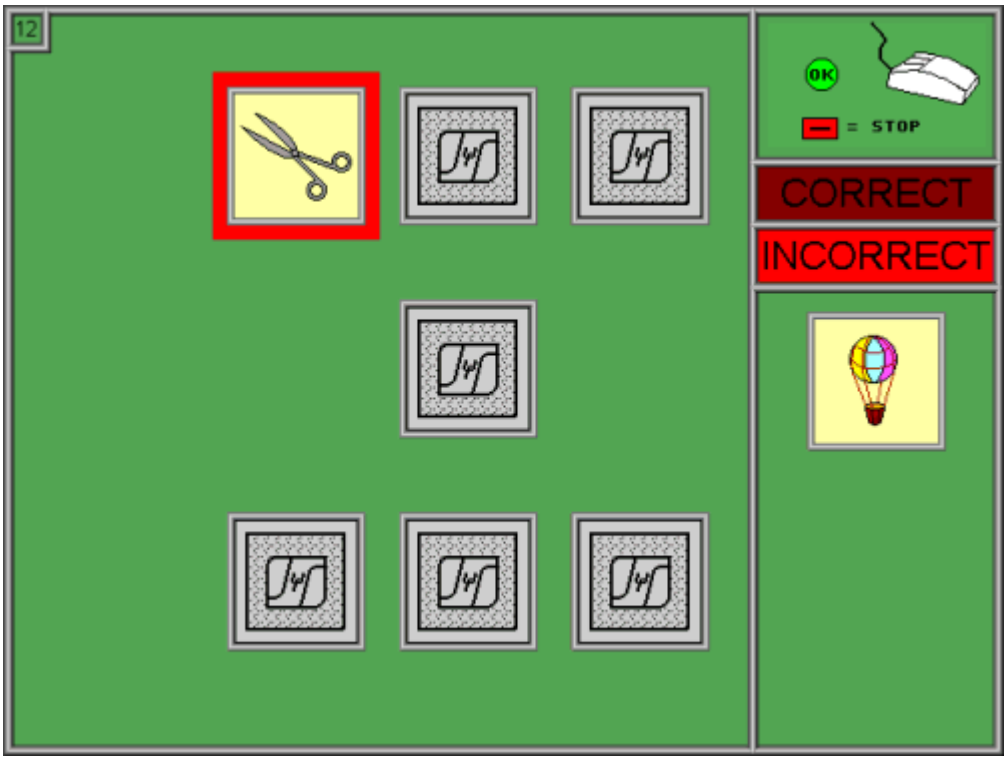
- by using the large cursor keys on the RehaCom-panel,
- with the Mouse or
- by Touch screen

(see Training parameter).

With the help of the cursor-keys the patient can move between the covered picture frames in the picture matrix and select the one which he thinks is correct. He confirms his choice by pressing the OK key.

When using a mouse, a cross is moved over the screen until the patient marks the desired picture. A highlighted frame signals if the cross is over a picture. Once again the patient confirms their choice by pressing the OK-key. Alternatively, the mouse button can be used for confirmation, depending on the patient's capability.

The easiest form of selection is with the Touch screen, whereby the patient simply selects the picture by touching it with his finger. when the patient removes their finger from the screen; this is taken as confirmation of choice.



Picture 2. The moment of an incorrect decision during a reproductions training, at a difficulty level of 12. On the right the picture which should have been selected is shown. On the left an incorrect picture has been selected, which can be seen briefly and then it is covered up again. The advice field "wrong" has also appeared on the right. This

incorrect decision precedes a row of correct decisions. Correctly chosen pictures have already been removed from the matrix of covered pictures. Above on the right the type of input mode is shown, in this case the large cursor keys were selected for input.
A green "correct" reference field appears when a correct decision has been made (see performance feedback). The picture is then removed from the matrix. When an incorrect decision is made the red field "WRONG" is highlighted. The incorrectly selected picture is shown for 5 seconds and is then concealed. Immediately pressing the OK-key or the mouse button shortens this time.

The reproduction phase ends when all of the covered pictures in the matrix have been paired. There then follows a performance feedback and thereafter, the next task.

The procedure can also be used without the Reha-Com panel.

1.2 Performance feedback

In the **acquisition stage**, the patient has to possibility to glance at an **active timepiece** which shows the remaining time, (see Training parameter) in which he must solve a given task. A clock is used (see Picture 1 on the lower right), which documents the total time required in a single go. On the one hand, with the aid of this clock, the patient can prepare themselves for the available acquisition time and where necessary, make better use of the provided time. On the other hand, it should be noted that this representation of the time remaining may have a negative stressful effect on some patients. For this reason, both the patient's personality and aspects of the mode of difficulty, of the task, should be taken into account when using this option.

In the **reproductions phase**, feedback occurs visually via the fields "correct" and/or "wrong" and by using color changes in the frames surrounding the pictures. After the choice of a wrong picture, it remains uncovered for 5 seconds; in order to document the mistake and the patient also has the chance to remember the contents of the incorrectly chosen picture, for future reference.A correctly selected picture is shown for 3 seconds and then it disappears from the picture matrix.

On the left at the top the current level of difficulty is shown.
(Picture 1 & 2).

1.3 Levels of difficulty

An adaptive type of set up, of the difficulty is guaranteed in this procedure.

The difficulty is determined by the number and the rate of variation of the pictures

which have to be memorised. Table 1 shows difficulty structure.

By means of an inter rate study, the pictures with regard to their rate of variation were assessed and by means of an empirical inspection the "threshold values" and strategies for alternation of the difficulty were determined. Nevertheless, only a few people manage to correctly complete the highest levels of difficulty. In general a patient's performance plateau is usually reached earlier in the programme.

Throughout the programme approx 500 pictures are used. At a rate of variation -level 1- pictures with concrete contents and heavily contrasted colours are shown. At level 2 the pictures as per level 1 become more abstract, however the heavily contrasted colours remain. In stage 3, coloured geometric representations are used. At level 4 with an even higher level of difficulty the colour information is greatly reduced and only monochrome geometric figures are employed.

Table 1 *Level of difficulty.*

Level	Matrix	Variation rate	Max number of errors	Max acquisition time
1	3	1	-	60s
2	4	1	2	60s
3	5	1	2	60s
4	6	1	3	60s
5	7	2	3	60s
6	8	2	4	75s
7	8	3	4	75s
8	9	2	4	75s
9	9	3	4	75s
10	10	2	4	75s
11	10	3	4	75s
12	12	2	5	90s
13	12	3	5	90s
14	12	4	5	90s
15	14	2	6	105s
16	14	3	6	105s
17	14	4	6	105s
18	16	2	6	120s
19	16	3	6	120s
20	16	4	6	120s

Changing to a higher level occurs when the patient, operating in the parameter mode for repetitions in the case of error, finally solves a task error free. The

patient falls to a lower level of difficulty when he exceeds the max number of permitted errors (see Table 1) for the level which he is on.
Thereafter a change to the next level, for a patient operating in the repetition mode, will only occur after the previous errors have been registered.

1.4 Training parameters

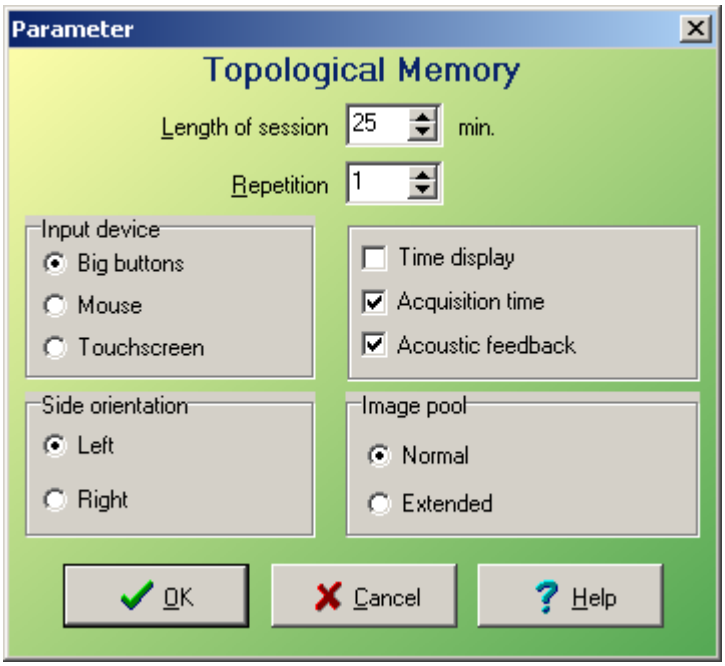
In the **RehaCom basic foundations**, general notes on the training parameters and their modification are given. Picture 3 shows the parameter menu.

Current level of difficulty
The level of difficulty can be set from level 1 to 20. This can be set up in the therapist menu (see **RehaCom basic foundations**).

Duration of training/cons. in min:
A training time of 25-30 Minutes is recommended.

Repetition:
A change in level occurs if the number of tasks have been correctly and/or incorrectly solved(repetitions considered). In this way, the level of difficulty is only modified if a - positive or negative - performance consolidation occurred. Therefore, it is more difficult to reach the next level, but intermittent performance problems do not directly cause the patient to fall to a lower level. The patient's motivation to train is then positively influenced. In general, it is recommended only to increase the level if a task is solved correctly and only after repetition of a series.

Input mode:
The variable possibilities for operating the programme (mouse, Touch screen, keyboard), has already been described. The use of the large keys on the RehaCom panel is recommended for patient's with coarse - stroke-tremor syndrome and for patients with other hand movement problems or simply in experienced patients.
For patients without motor problems, the mouse simplifies the handling of the programme.
The simplest type of operation is the Touch screen.



Picture 3. Parameter-Menu.

Orientation:
In order to consider patient's with particular lateral problems the training field links-rechts can be exchanged. This option is of interest for patients who have specific disturbances or who may favour a specific side of the screen (e.g. Neglect).

Indicated time of acquisition:
If ([X]) is activated, a clock shows the time available for acquisition. The visible clock is used to improve patient's performance and should not be used with patients whose performance is considered weak. (see performance feedback).

Limited duration of acquisition:
If the acquisition time is limited ([X]), the patient's time to memorise the picture will be limited (see table1). In general this option should always be used. In order to reduce the stress level for patients with a weak level of performance, this option can be disregarded ([ ]). However, after an improvement in performance, the limited time period should be activated again. The length of time for memo rising can be changed by the patient at any time, by pressing the OK key.

Acoustic Feedback
When the acoustic feedback is activated, a bell type noise is rung after each correct decision. When an incorrect decision is made a different type of bell tone is sounded. Many patients find the acoustic feedback to be very motivating. If a lot of people are working in the room the acoustic feedback should be turned off or head phones should be used.

Picture content:
RehaCom supports the use of additional set of pictures. The setting - picture series - **normal** - is automatically set up in the programme. An additional set of pictures - **extended** - is subsequently available. This series of pictures should be used after the patient has had a lot of experience with the first set of pictures. This helps to maintain motivation. The user may also generate their own set of pictures. An integration of the programme is quite simple. Please choose the system service option.

With a re-definition of the training the following default values are automatically set up:

Current level of difficulty	1
Duration of training/cons. in min	25
Repetition	1
Input mode	large keys
Orientation	left
Acquisition time indicator	off
Acquisition limited	on
Acoustic Feedback	on
Picture material	normal

1.5 Data analysis

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 interruptions by the patient
Pictures	Number of pictures in the matrix
Diff.-rate	Differentiate rate - pictures (1..4)
Errors	Number of errors
required Acquisitions time.	required Acquisition time
Solution time	required Reproduction time

The above helps the therapist to advise the patient on their short-comings.

2 Theoretical concept

2.1 Foundations

Memory is understood to be a process, which ends in an relatively stable variation of behaviour. (Kolb & Wishaw, 1985)

Impairments in memory performance with patients who suffer from injuries to the brain have in many cases very different origins. This can lead to vast hindrances in both professional and private life. The clinical appearances of such dysfunctions are inconsistent and can effect specific areas of memory, particularly in reference to duration and specific characteristics of the learning. When we talk about memory dysfunction we have to differ **retrograde Amnesia** from the **anterograde Amnesia**: the first defines the incapacity to remember a specific time frame before the illness; hilt the latter defines the inability (after a brain lesion) to hold or describe new information.

The first endeavours to understand and examine to complex function system of memory had already started at the beginning of the nineteen hundreds. In the foundational research and in the clinical everyday life the **short-term memory** and the **long-term memory** (Atkinson & Shiffrin1968, Warrington 1982); the procedural and the declarative (Cohen & Squire 1980), the semantic and the episodic (Tulving, 1972), the verbal, the non-verbal or the figurative memory, and the explicit and the implicit (Graf & Schacter, 1985) memory functions had been contrasted.

One of the classification systems of memory, with reference to recording and *storing of information*, follows from the results of the interdisciplinary foundational research:

- Sensory Memory (less than 100 ms)
- Short-term Memory (Broadbent, 1958; Wickelgreen, 1970) and Working Memory (cp. Baddeley 1990) with one second to one minute disposability of information.
- Long-term Memory with a retention time from minutes, to hours, weeks or years.

The capacity of the **short-term memory**, the memory span, averages by 7+-2 information units. The model of the **working memory** assumes that it works from various parties of neurological subsystems, which record predominantly visual-spatial and also to a large extent acoustic-linguistic information (Hömberg,

1995). In addition to the short-term "retention"of the information, the parallel processing of the contents is taken for granted. Indications of a functioning working memory are for example repeating and counting backwards or reproducing in reverse a previous visual memory span.

For a description of the **long-term memory** functions multiple differences must be dealt with in:

- the **explicit emery**, the knowledge data bank (semantic knowledge) and biographical data (episodic knowledge) were information is stored, which can be directly accessed and labeled, and
- the **implicit (procedural) memory** in which learned co-ordination and rules are stored, which cannot immediately be recalled or described verbally.(Hömberg, 1995),

Theories for *physiological* as well as *morphological* correlations of memory processes like long-term potentiality have been postulated by, amongst others, Hebb (1949; to be compared with Kolb & Wishaw). Model conceptions of the standard encoding, storage and accessing of the contents, resp. the organisation of which, is still very controversial.

An important result of research into memory is the current treatment of the memory as an integrative element of cognitive abilities. Memory functions are in this sense not just the process of **recorded information**, the long-term **storage** and procedures of **re-call** (in a sense a passive storage facility); but rather the means by which the content of memory has an effect on the future recording of information and the experience needed for the practical treatment of **side affects** (Hoffmann, 1983). And consequently modulate the emotional experiences of the individual.

The multi-variance of the memory area plays an important roll in the gathering of information for the memory function. The evaluation of the status of the cognitive abilities, is only possible after an extensive **analysis**, which includes the modularly-specific phase of memory, the short or long-term retention, as well as the re-call of new and old contents of memory (with or without help, and to recognise). Possible inferences could impair the storage and access of information, which should be taken into account in patients with unusual disturbances. The **Rivermead Behavioral Memory Test** (RBMT, Wilson 1992 is an example of a strong behaviour-orientations test, which test different areas of memory. Furthermore, the WMS-R (**Wechsler Memory Scale**) is a sophisticated diagnostic instrument in the cognitive realm.

Four ground breaking methods of rehabilitation of disturbances to memory distinguished as follows (cf.von Cramon, 1988):

- Repeated performance of learning material,
- Learning memory strategies,
- Use of external aids and
- Teaching of particular knowledge via the memory and possible disturbances (Glisky & Schacter, 1989).

During a visual perception performance a restitution seems possible by direct stimulation of the faulty functional area, it has now been discovered that in the case of memory processes, that a restitution is hardly possible in the case of a damaged function (Sturm1989).

That means that a neuropsychological training of memory functions should concentrate on *substitution* and *compensation* strategies.

The section Aim of training as well as Target groups provides more Information.

2.2 Training aim

The aim of training procedure is an improvement in **memory for visual-spatial information.**
MEMO is based on memo rising the spatial order of several figures in the acquisition phase and their assignment to the pool of concealed information in the reproduction phase.

By a means of ordering the defaulted pictures in a topological way, the possibility exists to elaborate and to consolidate (with practice), different memory strategies with the patient. One can resort for example to internal strategies like, firstly, the associative connection between seen subjects with the already available contents of the memory, and secondly first letter-priming (first letters of several terms have to be memorised and stored or recalled in a particular order). In addition a contents-related connection can be trained and learned by incorporating this information into a sentence, a devised story or a set of tasks.

Also, the so-called *Loci method* can be helpful during this type of training (a known system or series is subdivided into particular stations or places and these are then associated with certain objects/terms).

By using these "deeper" or more elaborate methods of processing information, a stronger retention capability is developed. Individual strategies inserted spontaneously by the patients should be dealt with. It should be kept in mind that

the processing of information, which take place automatically in healthy individuals, is consciously a difficult process for patients who suffer from amnesia. these additional strategies may then represent additional demands on the patients.

Further RehaCom procedures and the training of the **word memory** (WORD), of the **figurative memory** (BILD) or of the **verbal memory** (VERB). By using the **facial memory** (GESI) particular memory functions are trained; and with the programme **purchase** (EINK) more complex sets of tasks are trained, such as memory and action planning.

Topological aspects of visual information have a close connection to the 'cluster ability' of visual-spatial perception.

Problems in the visual-spatial perception and/or visual spatial operations are designated as neuropsychological symptoms, in which the two- or three dimensional spatial relationships which exist between different objects or parts of an object, cannot be registered.

For training of the visual-spatial perception in combination with spatial operation the following RehaCom-procedures/programmes are available **Two dimensional operation** (VRO1) as well as **Spatial operation**(RAUM) and can be supplemented by the programme **Visual-construction abilities** (KONS). *Attention and concentration* problems should be trained well in advance with the programme **Attention and concentration** (AUFM).

2.3 Target groups

Patients who suffer from a form of brain damage often find it difficult to learn new information and they have problems storing or re-calling this information from the *long-term memory*.

In combination with an increased level of distraction and other *attention troubles*, it is difficult for these patients to remember a summary of the information when confronted with by larger amounts of information. They also have difficulties coding information in order to support a more durable type of retention. Inefficiencies in the working memory and disturbances in attention prevent a transfer of the information content into a longer-term form of retention.

Such disturbances of memory can appear after numerous different types of injuries to the brain (primary- and secondary-degenerative illness of the brain, Hypoxie, infections and so forth) as well as in the case of vascular cerebral

injuries (infarcts, hemorrhages), skull-traumas and tumours with subsequent lesions which occur unilateral or on both sides of the brain. Also following a neurosurgical intervention, for example in the case of epilepsy, there are often disturbances to memory. After incurring damage the medial temporal or thalamic areas, mamillary body or basal front brain structures, gyrus parahippocampal or hippocampus are structures which, almost always result in disturbances to memory. During infarcts, the areas of the anterior cerebral artery and posterior cerebral artery as well as the polar thalamus artery are above all of great importance, when we talk of disturbances to memory.
The memory for *visual contents* is often damaged after *insults/strokes* to the right hemisphere. The probability of problems occurring in *verbal memory* is considerably greater after injuries to the *left hemisphere*.

Disturbances to the visual-spatial memory, which often occur after posterior strokes to the right hemisphere are often blended with deficits to the visual memory.

Disturbances in memory are more often accompanied by different disorders in brain performance, like attention and linguistic problems, which through the 'blending effect' complicate neuropsychological dagnostic and have a negative effect on memory performance in everyday life (Coding, re-call). Also problems in the patient's ability to *plan actions*, and their *problem solving skills* or a *lack of insight into the illness* can complicate therapeutic measures because an independent use of strategies often occurs at inadequate measure.

The training procedure was developed, above all, for patients with **disturbances to memory visual, where problems occur in ordering visual stimuli**. Furthermore, the training is suitable for patients with **disturbances to their visual range and for patients who suffer from weaknesses with recognition**. This training can also be defaulted to suit patients with aphasia problems.

The diagnostic of serious attention problems and considerable deficiencies in the visual perception functions should be excluded (perhaps previous training of these deficiencies should be carried out with the RehaCom procedure **attention & concentration**).

This type of training can be also be used to assist in the improvement in the performance of memory in the field of geriatrics and also with children from approx. 11 years. With children, it is advisable that a therapist is available at all times. The procedure can be used for child patients younger than or just 5 years of age for when appropriate instructions are used. At this age it is recommended that the Touch screen or the mouse should be used. Experience has shown that the operation of the keyboard was too difficult at this age.

For the procedure MEMO, numerous effectiveness studies are in the currently available for different random samples of patients : Friedl-Francesconi (1995, 1996) tested several Rehacom procedures on dementia- and trauma patients and achieved group improvements in memory and attention functions; with the latter excluding the visual short-term memory. In a study by Höschel (1996) the effectiveness of different RehaCom procedures was tested in later rehabilitation of trauma patients who had disturbances in memory and attention: improvements in individual functions were also shown here, in the higher pre post comparison test. Preetz (1992), Puhr (1997)and also Regel & Fritsch(1997) evaluated, MEMO on different patient groups and found among other things improvements in cognitive services in the raised tests (Pre post comparison) and partial relevant transfer effects in everyday life. A controlled effectiveness study on 3 experimental groups of alcoholics is available from Günthner(1992). With this he proved that the "RehaCom group" had the highest improvements in the non-verbal memory performances (Benton-Test). Günthner (1994) was able to prove similar improvements with schizophrenic patients, with a single 2 x 2 experimental setup (and also with the Benton-Test). Liewald (1996) and Wenzelburger (1996) were able to prove improvements in performance of the visual memory of alcoholics. The first stud was highly dependent on the "age" and the "seriousness" of the alcoholic problem. Pfleger (1996) found non-specific effects with regard to the illness process of chronic schizophrenics.

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