HASOMED

RehaCom®

Cognitive therapy

Divided Attention

www.rehacom.com

HASOMED
RehaCom®

Cognitive therapy

by Hasomed GmbH

This manual contains information about using the RehaCom therapy system.

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

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

User assistance information:

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

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

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

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

Table of contents

1 Training description

1.1 Training task

When using the Divided Attention module, the patient works as the driver of a train who sits in the steeple cab (or driver's cab) of the train and has the following task:

The patient must observe the control panel of the train and the countryside carefully, and react to different events as they occur. At first, only the acceleration of the train has to be changed. Later on, and with increasing levels of difficulty, more tasks are added; different levels of attention and particular reactions are expected from the patient.

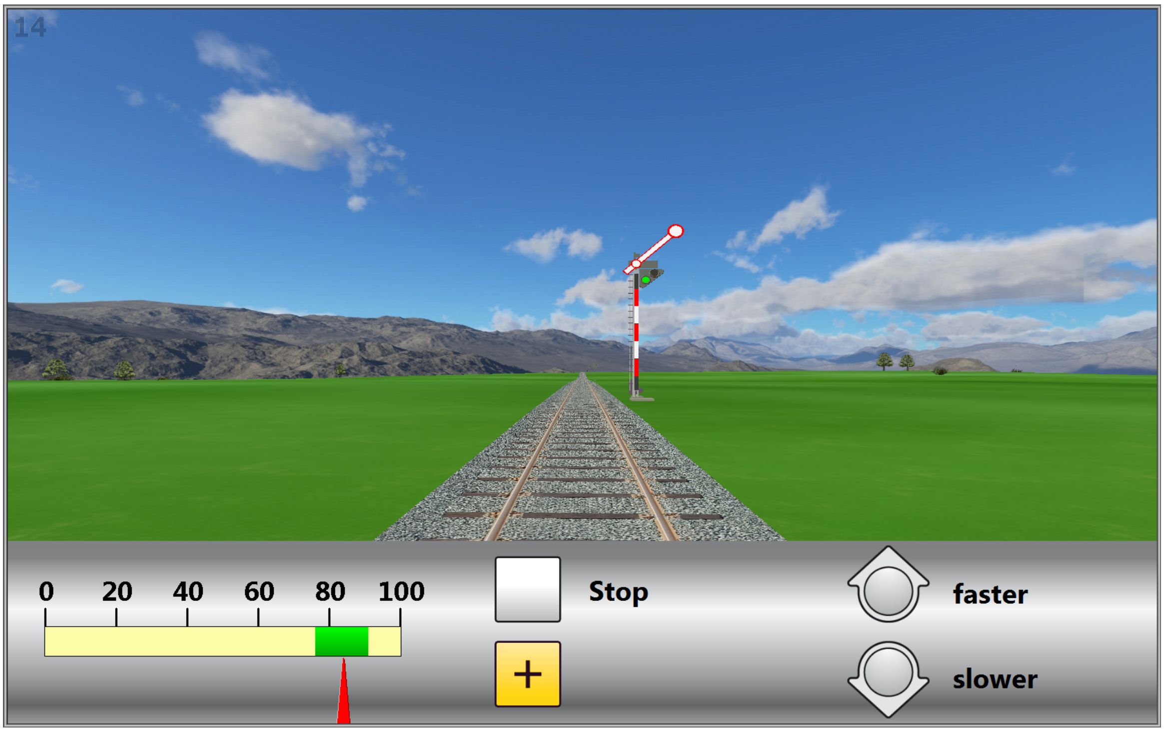

Fig. 1: Training on level 14, green semaphore signal, no reaction

On the screen, the view through the front windshield of a train and the driver's control panel is simulated (see Fig. 1). Through the window, you can see railway tracks which disappear in the distance. When the train is set in motion, by pressing the cursor button on the RehaCom keyboard, irrelevant stimuli (e.g., trees, houses, bushes, rocks) as well as relevant stimuli (e.g., train signals) appear on the screen. No reaction is expected from the patient when it comes to irrelevant objects. When it comes to relevant objects (e.g., a stop signal or a man waving a red flag above his head), the patient has to stop the train by pressing the OK button. In addition to variations in the approaching relevant objects, the status of the irrelevant objects, the train tracks, and the color of the countryside, can also change.

The driver's control panel contains, on the right, the speedometer with an acceleration display of up to 100 mph. The actual acceleration is indicated by a large red arrow. The train increases in speed when the up or right arrow is pressed, and it slows down or stops when the down or left arrow is pressed.

There is an analogy behind the direction of the arrows for acceleration and deceleration: faster = arrow in driving direction, slower = arrow in the opposite direction. Alternatively, the analogy for the left and right arrows is that the movement of the needle in the speedometer is from left to right. This allows for a more comfortable handling for the patient. In order to maintain clarity in the help menu, this train control panel only displays the symbols for "up arrow" and "down arrow." The arrow keys of the patient´s control panel are also called "acceleration/brake keys." In the example of the speedometer shown above, the green area represents the desired speed that the train should be travelling. The desired speed changes throughout the training and has to be regulated individually by the patient.

Also to be found on the driver's control panel are two lights.

- the yellow "+" light
- the "emergency brake" light (field highlighted in red randomly)

In real life, devices in a train driver's cab are similar to the ones simulated by RehaCom. The "+" light corresponds to a button that is intended to prevent the train driver from falling asleep or to keep the train from driving on without a driver. In RehaCom, the train stops automatically if the yellow "+" light on the patient's control panel is not pressed within a certain period of time.

The red emergency brake light is to stop the train in case of emergency. Whenever this light flashes red, the driver has to stop the train immediately by pressing the red "-" button or the OK button.

To begin a task or to re-start an interrupted task, the up arrow for "faster" on the driver’s control panel flashes.

To reduce amnestic components of the training, only four buttons have to be used by the patient on the RehaCom keyboard:

- "up arrow" (or right arrow) to accelerate,
- "down arrow " (or left arrow) to brake,
- OK button to stop the train,
- "+" key as a driver safety device**.**

A relevant stimulus does not appear until a task has been solved correctly. Consequently, the patient is less likely to become confused when deciding which objects are the relevant ones. For example, when first starting the train, it should be pointed out that a change in speed is recorded only when the red arrow enters the green "desired speed" area. Only then will the next relevant stimulus appear. After the train has stopped following the emergency brake signal, a "faster" arrow flashes which lets the patient know that the journey continues. If the desired speed has not been reached within 15 seconds, RehaCom registers a mistake by providing the information "late reaction at change of speed." If the patient fails to re-start the train within these 15 seconds, RehaCom also registers a mistake and the patient is requested to press the "faster" key.

The RehaCom module Divided Attention contains instructions that vary from level to level. For each level that has new tasks, explanations are given before beginning the task.
Each level of difficulty can also include staggered instructions. By clicking on the menu item "Start with instructions" in the Therapist menu, the appropriate instructions to the current training level can be created.

This module can also be used without the RehaCom keyboard.

1.2 Performance feedback

If the acoustic feedback is enabled in the parameter menu, a recorded voice will let the patient know if he/she made a mistake.

If the patient shows no reaction when the yellow “+” light turns on within the given time period, the train will stop automatically. If the patient´s response to a signal is not correct or if he/she fails to show reaction to an emergency brake signal, the train will stop. This mechanism is to prevent confusion.

After having completed a level, information on the mistakes made will be provided, such as:

- You reacted too late to a change of speed.
- You did not reach the desired speed in time.
- You ignored signals.
- You ignored the yellow plus"+" sign.
- You ignored the emergency brake.
- You pressed the wrong button.

1.3 Levels of difficulty

RehaCom is an adaptive system. The Divided Attention module has 14 levels of difficulty, which are described below. The appearance times of the objects vary stochastically by +-50%.

Attention level 1: Change the speed of the train - a continuous process (still not divided attention).

Level	Description
1	Change the speed of the train up to 100mph; change the desired speed of the train after approx. 20 seconds. Max. reaction time allowed: 5 seconds.

Attention level 1+2 (first level of divided attention): Apart from the change of speed, up to 50mph, the environment around the train has to be observed carefully for any changes as well. Whenever the "stop signal" (horizontal position, red light) appears, the STOP key (OK button) has to be pressed until the signal disappears. Apart from the "stop signal" there is also the "free travel signal" (angle of 45 degrees, green light), meaning the driver may proceed normally; therefore the driver must not stop. In level 1 and between level 5 and 14, there is a constant time interval between the objects, which can be adjusted by to the parameter (factor) "pause between objects." In order to prevent the patient from getting overwhelmed by upcoming objects, the time interval between them is rather long in level 2, whereas in level 5 the time interval is shorter. That is, the time interval decreases step by step until level 5 is reached.

Level	Description
2	Change of desired speed after approx. 20 seconds Max. reaction time allowed: 4 seconds
3	Change of desired speed after approx. 15 seconds Max. reaction time allowed: 3 seconds
4	Change of desired speed after approx. 10 seconds Max. reaction time allowed: 2 seconds

Attention level 1+2+3: In addition to the requirements of level 3 (change of speed up to 50mph, change of desired speed after approx. 15 seconds, max. reaction time allowed: 3 seconds, stopping the train by pressing OK whenever the stop signal appears), the patient has to watch for the yellow “+” light as well. Whenever a yellow light flashes on the "+" key of the driver's control panel, the "+" key on the patient's keyboard has to be pressed.

Level	Description
5	Yellow “+” light after approx. 25 seconds Max. reaction time allowed: 5 seconds
6	Yellow “+” light after approx. 25 seconds Max. reaction time allowed: 4 seconds
7	Yellow “+” light after approx. 20 seconds Max. reaction time allowed: 3 seconds
8	Yellow “+” light after approx. 15 seconds Max. reaction time allowed: 2 seconds

Attention level 1+2+3+4: In addition to the requirements of Level 8 (change of speed, looking out for stop and free travel signals and the yellow “+” light), a red light representing the emergency brake flashes on the driver´s control panel. To respond correctly to this sign, the driver has to stop the train by pressing the STOP key (OK button).

Level	Description
9	Red light after approx. 180 seconds. Max. reaction time allowed: 2 seconds.
10	Red light after approx. 90 seconds. Max. reaction time allowed: 1.5 seconds.

General increase of speed in the four Attention levels.
At this level there are further signals (red traffic lights, a man holding a red flag) that have to be responded to by pressing the STOP key (OK button). In addition, the speed of the train is increased.

Level	Description
11	Requirements of level 10, with change of speed after approx. 15 seconds (max. reaction time 3 seconds), responding to stop signals by pressing STOP key, responding to yellow "+" light after approx. 20 seconds (max. reaction time allowed 3 seconds), red light or free travel signal after approx. 180 seconds (max. reaction time allowed 2 seconds)
12	Requirements of level 11, but change of speed up to 65 mph, possibly red and green traffic lights (stop at red traffic lights with OK button)
13	Requirements of level 12, but change of the speed up to 80 mph
14	Requirements of level 13, but change of speed up to 100 mph, possibly man holding a red flag. (Stop with OK button)

Level no.	**Max. speed [mph]**	**Speed regulation after [s]**	**Max. speed reaction time [s]**	**Relevant signal after [s]**	**Yellow “+” light after [s]**	**Max. yellow “+” light reaction time [s]**
1	100	20	5	-	--	--
2	50	20	4	30	--	--
3	50	15	3	60	--	--
4	50	10	2	60	--	--
5	50	15	3	60	25	5
6	50	15	3	60	25	4
7	50	15	3	60	20	3

8	50	15	3	60	15	2
9	50	15	3	60	20	3
10	50	15	3	60	20	3
11	50	15	3	60	20	3
12	65	15	3	60	20	3
13	80	15	3	60	20	3
14	100	15	3	60	20	3

Tab. 1: Levels of difficulty part 1

Level no.	Emergency brake after [s]	Max. Emergency brake reaction time [s]	No. of different relevant signals [-]	No. of different irrelevant signals [-]
1	--	--	--	4
2	--	--	1	2
3	--	--	1	4
4	--	--	1	4
5	--	--	1	4
6	--	--	1	4
7	--	--	1	4
8	--	--	1	4
9	180	2	1	4
10	120	1,5	1	4
11	90	1,5	1	3
12	180	2	2	4
13	180	2	3	5
14	30	2	4	6

Tab. 2: Levels of difficulty part 2

1.4 Training parameters

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

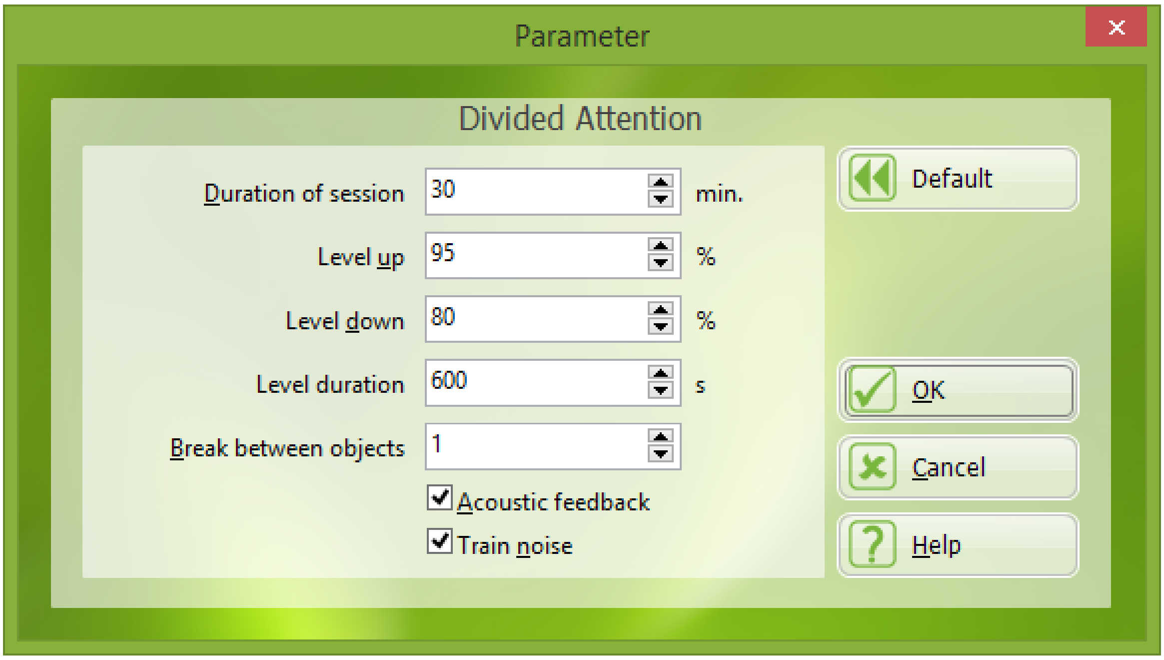

Fig. 2: Parameter menu

Duration of session:
A training session from 25–30 minutes is recommended.

Level up:
At each level, a percentage value is calculated. This percentage represents those tasks answered correctly within the set reaction time, in relation to the total number of relevant objects. Whether the driver progresses to the next level depends on a particular number of correct responses that have a greater average than the percentage value listed in the Level up setting.

Level down:
When too many incorrect answers have been given or the reaction time was too long, RehaCom automatically switches to a lower level of difficulty at the end of a task; the patient continues at a lower level. If the percentage value calculated is at the threshold between Level up and Level down, the patient stays at the same level.

Level duration:
The duration of a level can be altered to meet the individual needs of a patient. The duration can also be considered a factor in deciding whether or not to change the level of difficulty.

Pauses between objects:
This setting specifies the interval between two upcoming objects. Depending on a factor between 0 and 9, RehaCom determines how many pauses are necessary between two irrelevant objects. With a high number of irrelevant objects (factor 0), a patient can improve his/her receptiveness. The challenge of observing the environment, including not only the ability to be attentive but also the ability to react

quickly, is then increased. Therefore, it is only recommended for patients with less limited brain performance. Patients with weak brain performance are recommended to train with fewer irrelevant objects (factor >4).

Acoustic feedback:
To inform a patient about mistakes or exceeded reaction times, RehaCom uses a recorded voice as acoustic feedback. That way, it is easier for the patient to analyze the problems and to draw the right conclusions. When there is more than one patient in the room where the training takes place, it is recommended to use headphones in order to prevent acoustic interference. For patients with high brain performance, the acoustic feedback function can be disabled. Those patients are informed about mistakes after having completed a level.

Train noise: (driving noises)
As an additional distraction, driving noises of the train can be enabled. This function may also improve the sense of reality.

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

Level of difficulty	1
Duration of training	30 minutes
Level up	95%
Level down	80%
Level duration	600 s (10 min)
Break between objects	1
Acoustic feedback	enabled
Train noise	enabled

Tab. 3: Standard parameter

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
Stimuli	Number of relevant stimuli
Mistakes button	Number of incorrect reactions at "change of speed"
Mistakes required speed	Non-compliance with the required speed
Omissions	Number of non-reactions to relevant stimuli
Omissions %	Non-reactions to relevant stimuli in %

Speed changes	Number of speed changes
Omissions speed change	Number of "late reactions or no reactions at change of speed"
No. signals	Number of signals
Omissions signals	Number of "late reactions or no reactions at stop signals"
No. yellow "+" light	Number of yellow "+" light
Omissions yellow "+" light	Number of "late reactions or no reactions at yellow "+" light"
No. emergency brake	Number of flashing emergency brake
Omissions emergency brake	Number of "late reactions or no reactions at emergency brakes"
Train. time task	Actual training time in h:mm:ss
Breaks	Number of interruptions made by the patient

Tab. 4: Results

The parameter settings used during the training are displayed directly below the table. The graphical presentation of the results (e.g., percent omissions, mistakes required speed) 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

The term ***attention*** comprises functions which guarantee properly arranged external and internal sequences of objects in terms of contents and time. This enables conscious, orientated organisms to create a rational picture of life. This is achieved by a selection and integration of relevant information from different modes of perception.

Broadbent (1958) based his "bottleneck or filter theory" on the assumption of a limited processing capacity for incoming sensory information for an organism. That is, if stimuli are presented simultaneously, then a person can respond to selected stimuli and suppress the other stimuli. There are a range of input channels for every mode of perception, where information is filtered. Sternberg (1969; as cited by Keller & Grömminger, 1993) distinguishes in his *action orientated model of attention* between 4 phases:

1. Perception,
2. Identification of relevant impulses,
3. Choice of the reaction, and
4. Activation of a motor program in reaction to a stimulus.

These processes are partially automatic; with the registration of specific aspects of situations, active analysis processes are set in operation. Automatic processes operate parallel and need a smaller capacity. All other processes, however, take more time because they require a serial manipulation which requires larger attention capacities.

The ability of directional attention is a prerequisite for general cognitive performance skills. A lack of attention and concentration results in a limited receptiveness and processing capacity, a reduced information processing speed, increased fatigue especially under stress, and an increased tendency to be distracted. Thus, patients are restricted when doing intellectual and practical activities.

Empirical studies have shown that attention is not a uniform construct. In fact, the four attention aspects are to a large extent independent from each other and can be distinguished as follows (Fimm, 1997; Sturm, 1990; Sturm, Hartje, Orgaß, & Willmes, 1994):

1. phasic activation, alertness
2. selective attention
3. divided attention
4. tonic activation, vigilance

Phasic activation is defined as the ability to rapidly increase the activation level for a subsequent reflex situation, rapidly reacting to a warning stimulus (alertness).

Tonic activation, however, is an attention level which stays stable for a longer period of time.

Selective attention is considered the action of focusing on specific aspects of one task while ignoring irrelevant stimuli. This ability to select and integrate defined stimuli/objects is closely linked to the term *power of concentration,* which is defined as a short-term attention span (lasting for several minutes) that allows for recognition of relevant stimuli (Sturm, 1990).

Tasks requiring **divided attention** abilities have to include at least two stimuli to look for simultaneously. This aims to encourage the patient to respond both to relevant simultaneous stimuli and to relevant sequential stimuli. One example of divided attention is a situation where the driver of a car has to drive on an overcrowded street during rush-hour while talking to his/her passenger. When there are many stimuli presented at the same time, they interfere with each other. Thus, mistakes are likely to be made, and performance decreases.

Vigilance refers to attention abilities with small stimulus density over long periods of time. Attention abilities where situations present a high temporal density of relevant stimuli are referred to as continuous attention.

The ability to focus attention on relevant stimuli is dependent on internal variables (e.g., physiological state, cognitive processes, emotions) and external factors (e.g., stimulus intensity, contrast, color, shape, spatial relation). Attention can be focused automatically (i.e., involuntarily) through especially intense or novel stimuli (with high information content) by an orientation reflex. Cognitive processes modulate the current *attention status* through thoughts, motivations and interests. In particular, the selectivity of attention is constantly influenced by emotional associations. Whether or not the selectivity is maintained, also depends on individual motivation.

Empirical studies with laterally presented stimuli that were carried out among healthy people and split-brain patients suggest the right hemisphere of the brain has special relevance regarding control and maintenance of elementary activation processes (Sturm, Hartje, Orgaß, & Willmes, 1994). This concerns all patients with attention deficits, regardless of individually varying kinds and degrees of those deficits. After cerebral strokes leading to dysfunctions, the attention system is highly *vulnerable*, since it is closely linked to brain fields and brain structures.

In a psychological performance diagnosis, especially in clinical-neuropsychological assessment, tests for the examination of attention capabilities are essential. The fields of attention mentioned earlier differ in their functions. Apart from paper-and-pencil tests, test batteries for attention tests of the Vienna test system and the ones of Zimmermann & Fimm (1989) allow for a different view on impaired brain functions.

According to the Diagnostic and Statistical Manual of Mental Disorders (5th ed.;

DSM–5), attention disorders in children are defined as a persistent pattern of inattention, impulsiveness and hyperactivity that interferes with functioning or development (American Psychiatric Association, 2013).

In diagnostic practice, the evaluation of attention mostly occurs through "surface parameters" such as:

- the required time,
- the number and kind of mistakes,
- the development of mistakes over time, or
- the processed amount of submitted material when fulfilling specific tasks.

The advantages of such a diagnostic procedure lie in the extraction of measurable variables, both intra-individual (course of disease, therapy evaluation) and inter-individual (based on the measurements of a standard group).

Efforts to improve adult patients' attention skills by doing cognitive brain performance training have increased (Säring, 1988). In cases where the cerebral area is damaged, the demand for rehabilitation is particularly high because 80 percent of all brain injuries results in attention and concentration problems (Poeck, 1989; Van Zomeren & Brouwer, 1994).

For further information, please see the sections Training aim as well as Target groups.

2.2 Training aim

More recent research results recommend a differential approach to training, which deals with specifically targeted disturbances in attention, because less theoretically based or unspecific training tests have not been successful in all aspects of attention (Gray & Robertson, 1989; Sohlberg & Mateer, 1987; Poser, Kohler, Sedlmeier, & Strätz, 1992; Sturm, Hartje, Orgaß, & Willmes, 1994; Sturm, Willmes, & Orgaß, 1997).

The RehaCom module Divided Attention 2 is designed to train patients to overcome deficits in divided attention performance. This module also helps patients to improve their general reaction time. In particular, patients can improve their ability to simultaneously process both visual and acoustic stimuli while ignoring irrelevant stimuli. Because the Divided Attention 2 module is an adaptive training module, patients prone to interference are not overwhelmed by too many stimuli at higher levels of difficulty. At a longer set training time, this module trains the patient's vigilance as well.

When it comes to computer-assisted training of either single or several attention components, experience has shown (e.g. Fernández et al., 2012) that patients primarily improve during the post-acute phase after suffering a stroke.

Working with computers offers a wide range of advantages. By providing systematic performance feedback, the patient can develop a better self-perception, in order to use his or her attention capacities in the most efficient way possible.

From a therapist's point of view, it is important that the patient is not only confronted with the deficits but also learns to develop strategies to cope with and compensate for them (e.g., to avoid certain stress factors or use external help in specific situations of requirement). Relatives could also be included in order to reduce stress levels.

The improvement of attention is a basic objective for the training of further cognitive functions. It is of fundamental importance for the treatment of memory disturbances (information recording as precondition for storage).

On the basis of results of diagnosis, it should be decided if the Divided Attention 2 module is used alone for therapy or in combination with additional modules. In most cases, it would be considered important and favorable when a basic training in attention is used first (e.g., Attention and Concentration).

2.3 Target groups

Attention disorders after functional or organic interference are the most frequent neuropsychological performance deficits after brain damage (Van Zomeren & Brouwer, 1994). Attention deficits affect 80% of patients after stroke, traumatic brain injury, diffuse organic brain injury (e.g., alcohol abuse or intoxication) or other diseases of CNS.

Conceptually, one suggests different attention functions which can be disturbed selectively. Diffuse brain injuries after traumatic or hypoxic etiology are often followed by unspecific attention deficits such as rapid fatigue, an increased need for sleep, and a general loss of motivation. Localized insults, however (e.g., after vascular genesis), often lead to specific attention deficits. Fundamentally, insults of any cortex area can cause attention disturbances. Especially after lesions of the brainstem in the region of the reticular formation or after lesions of the right parietal cortex, disturbances in phasic or tonic alertness and in vigilance have been reported. Left-sided cortical lesions, on the other hand, damage aspects of attention selectivity, and is especially noticeable in tasks requiring a choice between a range of stimuli and reaction alternatives (covert shift of attention) (Sturm, 1990).

After injuries to the brain, patients often report difficulty directing their attention in parallel towards different stimuli or impulses (Zimmermann & Fimm,1989).

There are numerous situations in everyday life in which divided attention is required (e.g., budgeting, driving, communicating in social situations). Problems with the processing of parallel information can be seen through a general reflex slow-down, a

restriction of capacity for the processing of a sensory stimulus, or a lack of cognitive flexibility.
Also the problems described as interference vulnerability or increased disturbances in control, which can be observed after a brain injury, may be evaluated as symptoms of a limited information processing capacity. These patients complain about a great "flood of information," and often feel disturbed by different influences, and they can only prepare themselves exclusively for one circumstance or situation.

With this in mind, *emotional problems* must also be considered and may cause special strain in social situations as a result of focusing on the attention difficulties.

One should also consider the possibility to train for these particular deficits in the different aspects of attention.

This module is particularly suitable for patients who suffer from disturbances affecting their divided attention performance.

Using the premise of maximum specificity and to achieve the highest possible efficiency in the training, one should start with a differentiated singular *neuropsychological* diagnostic before preparing the therapy plan that includes computer-assisted procedures.

The module Divided Attention was examined with other RehaCom modules in two controlled studies with patients who suffered stroke or traumatic brain injury: research reported by Puhr (1997) and Regel & Fritsch (1997) showed significant improvements in pre-post comparison.

It is possible to use this module with children from 10th grade without important intellectual development challenges; this is based on previous experiences. The module uses child-friendly instructions for patients of 14 years or younger.

2.4 Bibliography

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Ben-Yishay, Y., Piasetzky, E., & Rattock, J. (1987). A systematic method for ameliorating disorders in basic attention. In M. Meier, A. Benton, & L. Diller (Eds.). *Neuropsychological rehabilitation*. Edinburgh, Scotland: Churchill Livingstone.

Brickenkamp, R., & Karl R. (1986). Geräte zur Messung von Aufmerksamkeit, Konzentration und Vigilanz. In R. Brickenkamp (Ed.), *Handbuch apparativer Verfahren in der Psychologie*. Göttingen, Germany: Hogrefe.

Broadbent, D. (1958). *Perception and communication*. London, England: Pergamon Press.

von Cramon, D. (1988). Lern-und Gedächtnisstörungen bei umschriebenen zerebralen Gewebsläsionen. In W. Schönpflug (Ed.), *Bericht über den 36. Kongreß der Deutschen Gesellschaft für Psychologie*. Berlin, Germany.

Fernández, E.; Bringas, M. L.; Salazar, S.; Rodríguez, D; García M. E.; Torres, M. (2012). Clinical Impact of RehaCom Software for Cognitive Rehabilitation of Patients with Acquired Brain Injury International Neurological Restoration Center (CIREN 2012), Havana, Cuba in MEDICC Review, Vol 14, No 4.

Fimm, B. (1997): Microanalyse von Aufmerksamkeitsprozessen. In S. Gauggel & G. Kerkhoff (Eds.), *Fallbuch der Klinischen Neuropsychologie. Praxis der Neurorehabilitation* (pp. 25–38). Göttingen, Germany: Hogrefe.

Gray, J., & Robertson, I. H. (1989). Remediation of attentional difficulties following brain injury: Three experimental single case studies. *Brain Injury, 3*, 163–170.

Höschel, K. (1996). Effektivität eines ambulanten neuropsychologischen Aufmerksamkeits- und Gedächtnistrainings in der Spätphase nach Schädel-Hirn-Trauma. *Zeitschrift für Neuropsychologie, 7*(2), 69–82.

Keller, I. (1997). Aufmerksamkeitsstörungen. In S. Gauggel & G. Kerkhoff (Eds.), *Fallbuch der Klinischen Neuropsychologie. Praxis der Neurorehabilitation* (pp. 39–47). Göttingen, Germany: Hogrefe.

Keller, I., & Grömminger, O. (1993). Aufmerksamkeit. In D. Y. von Cramon, N. Mai, & W. Ziegler (Eds.), *Neuropsychologische Diagnostik*. Weinheim: VCH.

Lauth, G. W. (1988). Die Vermittlung handlungsorganisierender und handlungsregulierender Komponenten in der Therapie von Aufmerksamkeitsstörungen. In W. Schönpflug (Ed.). *Bericht über den 36. Kongreß der Deutschen Gesellschaft für Psychologie*. Berlin, Germany.

Lauth, G. W. & Schlottke, P.F. (1988). Aufmerksamkeitsstörungen. In: Schönpflug, W. (Hrsg.): Bericht über den 36. Kongreß der Deutschen Gesellschaft für Psychologie. Berlin.

Niemann, T., & Gauggel, S. (1997). Computergestütztes Aufmerksamkeitstraining. In S. Gauggel & G. Kerkhoff (Eds.), *Fallbuch der Klinischen Neuropsychologie. Praxis der Neurorehabilitation* (pp. 48–59). Göttingen, Germany: Hogrefe.

Poeck, K. (Ed.). (1989). *Klinische Neuropsychologie*. Stuttgart, Germany: Thieme-Verlag.

Poser, U., Kohler, J., Sedlmeier, P., & Strätz, A. (1992). Evaluierung eines neuropsychologischen Funktionstrainings bei Patienten mit kognitiver

Verlangsamung nach Schädelhirntrauma. *Zeitschrift für Neuropsychologie, 1*, 3–24.

Posner, M., & Rafal, R. (1987). Cognitive theories of attention and the rehabilitation of attentional deficits. In M. Meier, A. Benton, & L. Diller (Eds.), *Neuropsychological rehabilitation*. Edinburgh, Scotland: Churchill Livingstone.

Puhr, U. (1997). *Effektivität der RehaCom-Programme in der neuropsychologischen Rehabilitation bei Schlaganfall-Patienten*. Thesis at the University of Vienna.

Regel, H., & Fritsch, A. (1997). *Evaluationsstudie zum computergestützten Training psychischer Basisfunktionen. Abschlußbericht zum geförderten Forschungsprojekt*. Bonn, Germany: Kuratorium ZNS.

Regel, H., Krause, A., & Krüger, H. (1981). Konfigurationsfrequenzanalytische Einschätzung einiger psychometrischer Verfahren zur Hirnschadensdiagnostik. *Psychiatrie, Neurologie, medizinische Psychologie, 33*, 347.

Saring, W. (1988): Aufmerksamkeit. In D. von Cramon & J. Zihl (Eds.), *Neuropsychologische Rehabilation*. Berlin, Germany: Springer Verlag.

Sohlberg, M. M., & Mateer, C. A. (1987). Effectiveness of an attention training program. *Journal of Clinical and Experimental Neuropsychology, 9*, 117–130.

Sternberg, S. (1969). Memory-scanning: Mental processes revealed by reaction-time experiments. American Scientist, 57, 421-457.

Sturm, W. (1990): Neuropsychologische Therapie von hirnschädigungsbedingten Aufmerksamkeitsstörungen. *Zeitschrift für Neuropsychologie, 1*(1), 23–31.

Sturm, W., Dahmen, W., Hartje, W., & Wilmes, K. (1983). Ergebnisse eines Trainingsprogramms zur Verbesserung der visuellen Auffassungsschnelligkeit und Konzentrationsfähigkeit bei Hirngeschädigten, *Arch. Psychiatr. Nervenkr., 233*, 9–22.

Sturm, W., Hartje, W., Orgaß, B., & Willmes, K. (1994): Effektivität eines computergestützten trainings von vier aufmerksamkeitsfunktionen. *Zeitschrift für Neuropsychologie, 1*, 15–28.

Sturm, W., Willmes, K., & Orgaß, B. (1997). Do specific attention deficits need specific training? *Neuropsychological Rehabilitation, 7*(2), 81–103.

Van Zomeren, A. H., & Brouwer, W. H. (1994). *Clinical neuropsychology of attention*. Oxford: Oxford University Press.

Zimmermann, P., & Fimm, B. (1989). *Neuropsychologische testbatterie zur* *erfassung von aufmerksamkeitsdefiziten*. Freiburg, Germany: Psychologisches Institut der Universität.

Index

- A -

- B -

- C -

- D -

- E -

- F -

- H -

- I -

- L -

- M -

- N -

- P -

- R -

- S -

- T -

- V -