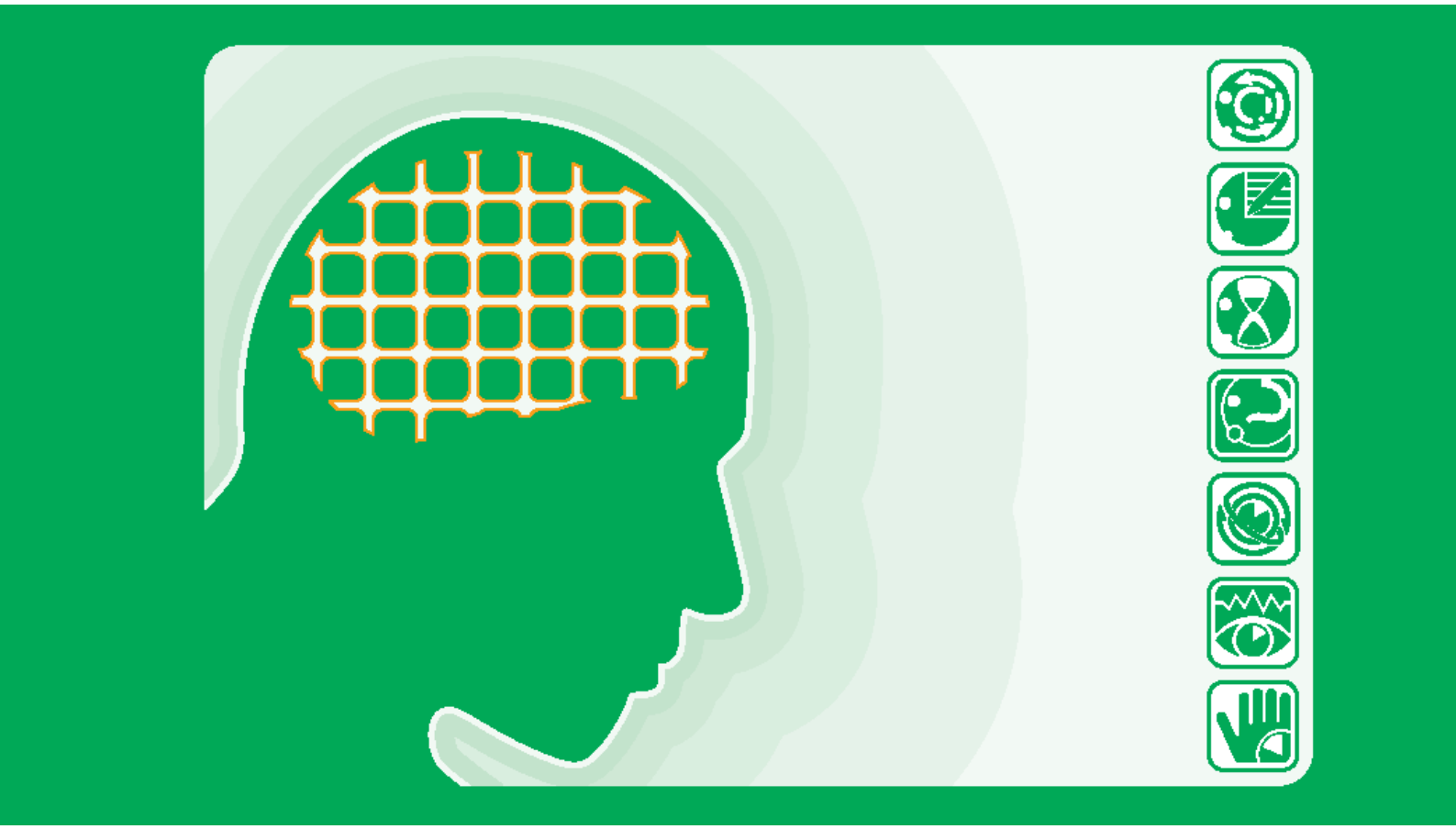
RehaCom

computer-assisted cognitive rehabilitation - brain performance training



Divided Attention

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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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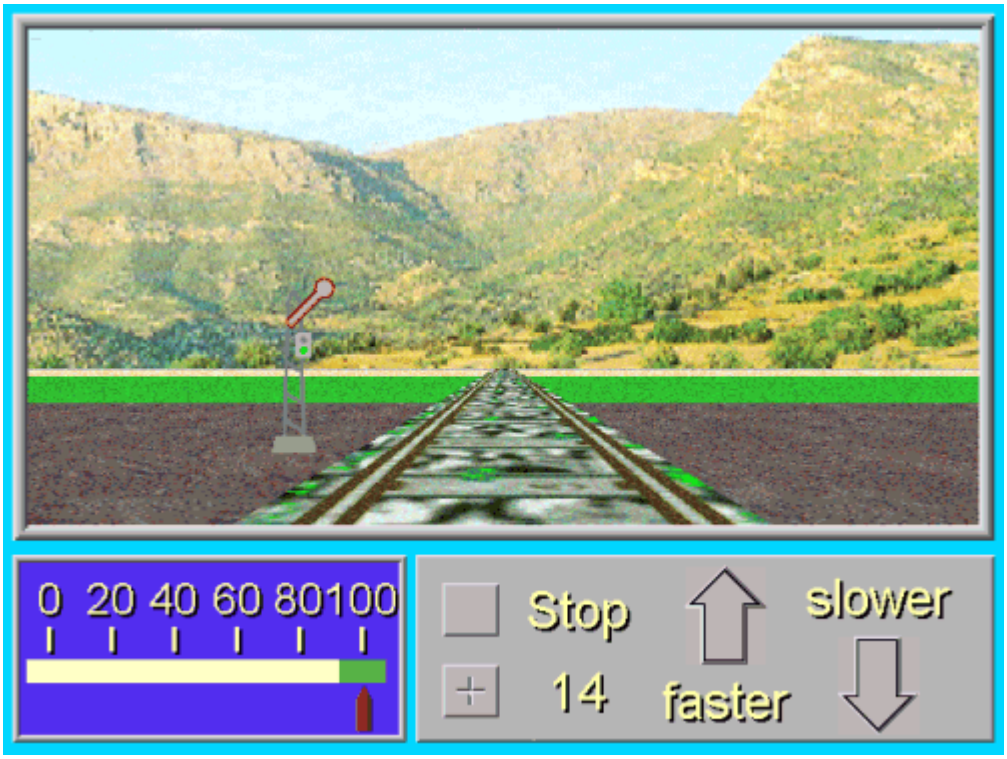
1 Training description

1.1 Training task

The Patient works through this Training as the driver of a train. He sits in the steeple cab (or driver's cab) of the train and has the following task:

He must carefully observe the control panel of the train and the countryside, as it flashes past, and react to different events as they occur. At first, only the acceleration of the train is to be regulated. Later, and with increasing levels of difficulty more tasks are added; in which different levels of attention and particular reactions are expected from the trainee.



Picture 1: Training on level 14, green signal, no reaction

On the screen, the view through the front windscreen of a train and the driver's control panel is simulated (Picture 1). Through the window you can see the railway tracks of the train, which disappear off into the countryside in the distance. When the train is set in motion, by pressing the cursor button on the RehaCom-panel, **irrelevant** objects (trees, houses, bushes,rocks) as well as **relevant** objects (e.g. train signals) flash past the viewers perspective and then disappear on the left-hand side and on the right, respectively . 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 must stop the train by pressing the OK button, that is, so long as the

object is still to be seen on the screen. Along with the approaching relevant objects, the status of the irrelevant objects, both left and right, the train tracks and the colour of the countryside, can also be altered. (yellow=sand, green=meadows, brown=cultivated fields, grey= rocks)

The driver's control panel contains, on the right, the tachometer with an acceleration display of up to 100km/h. The actual acceleration is shown by a large red pointer. This pointer is controlled by the patient's use of the cursor button ("Arrow up") for **"faster"** and ("Arrow down") for **"braking"**. The analogy behind the direction of the arrows is: **faster** = arrow in driving direction, and respectively **braking** = arrow in the opposite to driving direction. Alternatively, the system of "arrow to the left" = faster and "arrow to the right" = braking, could also be used. The analogy here is that the movement of the tachometer is registered from left to right. This allows for a more comfortable set-up for the patient. In order to maintain clarity in the help menu, this train control panel will only show the symbols, "arrow up" and respectively "arrow down". The patients control panel is marked with more than just acceleration and braking buttons. In the above example of the tachometer the green area shows the recommended speed that the train should be held at. This must always be regulated and maintained by the patient. This green area also varies according to each level.

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

- the "**deadman's**" lamp (Field with the "+" symbol, which when activate turns yellow) and
- the "**emergency stop**" lamp (Field, when activated turns red)

In the real situation, a similar organisation of the driver's cab exists. The so-called "Deadman's pedal" is supposed to prevent the train from going out of control if the train driver falls asleep or if there is some form of failure. In the RehaCom model, if the yellow deadman's lamp button ("+" on the patient's control panel) is not held for a defined period of time, the train will come to an automatic stop.

The red emergency lamp responds to a pulling of the emergency break or an initiation of a stop for some other reason. The Stop button (OK button) should then be pressed immediately.

In the middle of the panel a large number shows the current Level (1 to 14). On the right the large arrows refer to the acceleration and the break functions, respectively. To begin a task or re-start an interrupted task the

" faster" arrow will flash.

To reduce the mnemic components of the training, merely four buttons/keys have to used by the patient on the RehaCom control panel.

- "Arrow up" resp. "Arrow right" for ***Acceleration,***
- "Arrow down" resp. "Arrow left" to ***Brake,***
- OK-Key to ***Stop*** the train,
- "+"-Key as ***deadman's key.***

A relevant task first appears when the previous event/task has been dealt with correctly. In this way, the patient is less likely to be irritated and priority can be given to the relevant tasks. However, it should be pointed out that a change in speed is recorded when the red arrow enters the green "standard speed" area. From this moment, it is possible that the next relevant task may appear. Should the train stop, then the journey must be started again. Selecting the flashing "faster" arrow lets you re-start the journey. If, within 15 seconds the correct speed is not restored, a mistake is registered and "Reaction too slow to change of speed" is shown. If, during these 15 seconds the journey is not re-started a mistake is also registered and the patient is asked to press the "faster" key.

The RehaCom-System **Divided Attention** contains level dependant instructions. In this way, with each level of difficulty there are more tasks, which have to be solved. Each level of difficulty can also be given staggered instructions. Using the menu item "New start with instructions" in the Therapist menu, any of the current training levels can be set up with the corresponding instruction series.

This System can also be used without the RehaCom panel.

1.2 Performance feedback

When the acoustic feedback is activated, a short text (advice) is spoken if the patient makes a mistake.

If there is no reaction to the Deadman's lamp, within the given time period, the train will be automatically stopped. If the patient reacts in the wrong way to a signal or doesn't react to the emergency brake signal, the train is not stopped. This is to prevent irritation.

After working through a level the following mistakes can be mentioned:

- You have chosen the false key in reference to a change in speed.
- You have reacted to slowly to a change in speed.

. You have stopped the train for no particular reason.
. You have overlooked a signal.
. The Deadman's key was not activated.
. You activated the Deadman's key without reason.
. Please react faster to the flashing of the Deadman's lamp.
. The Emergency stop key was not pressed properly. Please react faster.

1.3 Levels of difficulty

The RehaCom system is an adaptive system. There are 14 level of difficulty defined. There follows a description of the levels, the appearance times of the objects varies stochastically from +-50%.

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

Level	Description
1	Regulate the speed of the train up to 100km/h; change the speed of the train for up to approx. 20 seconds. Max reaction time allowed - 5 seconds.

Attention level 1+2 (first level of divided attention) Along with the regulation of the speed, up to 50km/h, the observation situation is also added. With the appearance of a given "Arm signal", and as long as the signal is still visible, the STOP key (OK key) must be pressed.

Level	Description
2	Regulation of speed of the speed for up to 20 seconds. Max. reaction time allowed - 4 seconds.
3	Regulation of speed of the speed for up to 15 seconds. Max. reaction time allowed - 3 seconds
4	Regulation of speed of the speed for up to 10 seconds. Max. reaction time allowed - 2 seconds

Attention level 1+2+3 Alongside the requirements of Level 3 (the regulation of the speed, up to 50km/h, the appearance of closed "Arm signal", the operating of the STOP key) the operating of the deadman's switch is added. When the labeled lamp on the driver's control panel flashes yellow, the "+" key on the reaction panel must be pressed.

Level	Description

5	Operation of the Deadman's lamp for up to 25 seconds. Max. reaction time allowed - 5 seconds.
6	Operation of the Deadman's lamp for up to 25 seconds. Max. reaction time allowed - 4 seconds.
7	Operation of the Deadman's lamp for up to 20 seconds. Max. reaction time allowed - 3 seconds.
8	Operation of the Deadman's lamp for up to 15 seconds. Max. reaction time allowed - 2 seconds.

Attention level 1+2+3+4: Alongside the requirements of Level 7 (Regulation of the train's speed, attention to"Arm signals" and the Deadman's lamp) the operation of the emergency break, on the train's control panel, is also added. It is activated by pressing the STOP key(OK key). The train will then break.

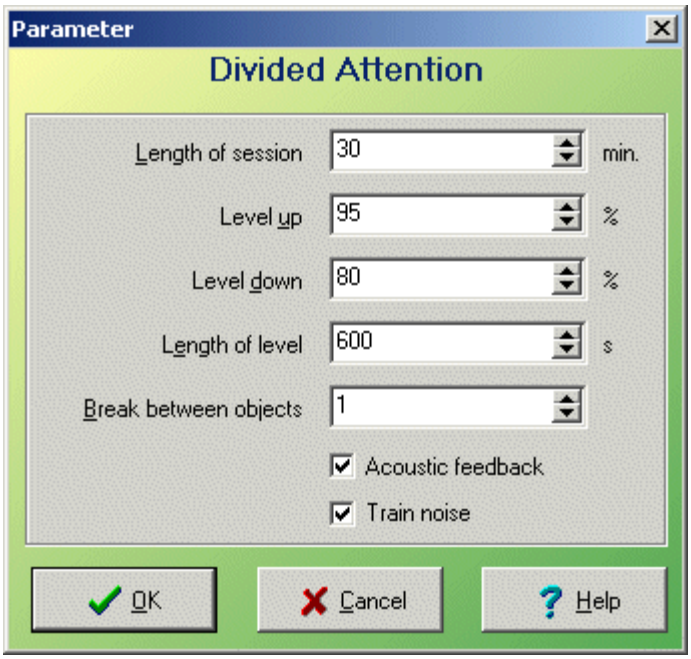
Level	Description
9	Reaction to the Emergency break lamp - duration approx 180 seconds. Max. reaction time allowed - 2 seconds.
10	Reaction to the Emergency break lamp - duration approx 90 seconds. Max. reaction time allowed 1 - 5 seconds.

General increase in the speed in the four Attention levels.
At this level there are more signals (red stop lights, a man with a red flag)which require the STOP key (OK key). The signals could also indicate continuous travel (open arm signals, green lights). In this situation the train should not be stopped. In addition the speed of the train is increased.

Level	Description
11	Requirements of level 9, with the regulation of speed - duration 15 seconds (max. reaction time 3 seconds), reaction to closed Arm signals, deadman's lamp - duration 180 seconds (max. reaction time 2 seconds) and open arm signals are also possible.
12	Requirements as per level 11 but with regulation of speed up to 65km/h, red and green lights also possible (stop at red lights with the OK key).
13	Requirements of level 12 but with regulation of the speed up to 80km/h.
14	Requirements of level 13 but with the regulation of the train's speed up to 100km/h, man with a red flag also possible. (Stop with the OK key)

1.4 Training parameters

In the **RehaCom basic foundations**, some general information (references) is given on the Training parameters and their properties. This information (references) should be taken into further consideration. Picture 2 shows the Parameter Menu.



Picture 2 Parameter Menu.

Current level of difficulty (therapists menu):
The level of difficulty, which ranges from 1 to 14 can be set in the Therapy Menu.

Length of session: (Duration of Training/consultation in min)
A training duration from 25-30 Minutes is recommended.

Level up: (Continue to the next level)
At each level a percentage value is calculated. This percentage reflects the tasks correctly answered, within the set reaction time, in relation to the overall relevant tasks which where to be completed. The next level of difficulty is started, when the **"sufficiently correct"** number of decisions have been made and the percentage level is valued to be enough for **"continue the the next level"**.

Level down: (Repeat the previous level)
A lower level of difficulty is automatically activated when **"too many"** incorrect answers or late decisions have been made Here the percentage value is calculated to reflect that the patient has fallen short and has to **"repeat the previous level"**. If the percentage value is calculated to be between **"continue**

the the next level" and **"repeat the previous level"**, then the same level of difficulty is repeated.

Length of Level: (Duration)
The duration time in a level is fixed. Thereafter, the duration time can be altered to suit the patient.

Break between objects: (pause)
An object -pause is defined as the time between the appearance of the object on the horizon and its disappearance. The time of the pause is then dependant on the speed of the train. A factor from 0-9 determines how long the time pause is between two irrelevant objects. When using a higher number of irrelevant objects (Factor 0) the patients divided attention is strengthened and improved. For patients with a high performance level, higher requirements of the divided attention and adaptability should be set. For weaker level patients, it is recommended that the number of irrelevant objects be reduced (Factor>4).

Acoustic feedback:
If the patient makes mistakes or reacts too slowly, spoken advice is given. In this way it is easier for the patient to analyse the problems and draw the correct conclusions. If there is more than one patient in the room, it is recommended that headphones be used to prevent interference. For patients with a high performance level, the acoustic advice can be deactivated. The patient would then find out what mistakes they made at the end of the level.

Train noise: (driving noises)
As an additional irritation the driving noises of the train can also be activated. This improves the sense of reality.

With the redefinition of a patient the following system of default values are automatically set in operation:

Level of difficulty	1
Duration of training	30 minutes
Continue to the next level	95
Repeat the previous level	80
Duration of level	600 s=10 min
Breaks between irrelevant objects	1
Acoustic feedback	on ([X])
Driving noises	on ([X])

1.5 Data analysis

The manifold possibilities for Data analysis and provisions for additional training strategies are described in the basic **foundations of RehaCom.**

In the Graphics, as well as in the Tables, and in addition to the settings of the Trainingsparameter ; the following information is also available:

Level	Current level of difficulty
Training time (actual)	Actual Training time
Pauses	Number of interruptions by the patient
Relevant Tasks	Number of relevant Tasks (Change in Speed, Signals, Emergency stop, Deadman's-Lamp), which require a reaction.
Errors in Speed.	Number of Mistakes "a late or no reaction in relation to a change of speed"
Incorrect Key	Number of mistakes "in relation to a change of speed - the incorrect key being pressed"
Error in Signals/Emergency stop	Number of mistakes "in relation to a stop signal a late or no reaction"
Error by Deadman	Number of mistakes "in relation to the Deadman's - Lamp a late or no reaction"

Therefore, it is possible to advise the patient on particular errors.

2 Theoretical concept

2.1 Foundations

When we refer to the term **Attention**, we refer to functions which are combined, through which external and internal sequences of events receive an arranged contents-related and temporal structure. This enables the conscious, orientated organisms, to create a rational picture of life. It achieves this by selection and intergration of different modes of perception.

Broadbent (1958) spoke of in his **"Bottleneck - or Filter Theory"** of a limited processing capacity, of incoming sensory information for an organism, so that in reaction to selective stimulation, suppression of intermittant impulses occur. From a contemporary viewpoint there exists several modal specific input channels, where information must be filtered. Sternberg (1969) (cp. Keller & Grömminger, 1993) separates these channels, in his action orientated Attention Model, into four phases:

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

These processes are partly automatic; and with the registration of specific aspects of situations, active analysis processes are set in operation. Automatic processes operate in a smaller capacity in parallel, whilst all other processes require a serial manipulation. This provides for a larger attention capacity and therefore can be dealt with slower.

The ability to observe attention represents a basic assumption for a general capability with regard to different cognitive orders. Intellectual and practical activities are damaged by **attention and concentration problems** which can be expressed in reduced photo and processing capacity, reduced information processing speed, rapid fatigue and above all an increase in distraction at a considerable measure.

On the basis of empirical investigations, one can assume that attention is not a homogeneous construction. Rather, the four attention aspects are to a large extent independent from each other and can be distinguished as follows (cf.Fimm , in 1997; cf. Sturm, 1990; .Sturm et al, 1994):

1. **periodic activation, Alertness**
2. **selective attention**
3. **divided attention**
4. **tonic activation, Vigilance**

Periodic activation is defined as the ability to increase the activation level for a subsequent reflex situation, rapidly reacting to a warning impulse (reflex readiness, Alertness), while for a relatively long time, stable attention level, **tonic activation** is designated.
The term **selective attention** focuses the action of reacting in a designated manner to specific aspects of a task, as it permits in a simultaneous manner fast reaction to relevant stimulus and also chooses to ignore irrelevant stimulus. This ability for the selection and integration of a defined stimulus or perception contents is narrowly associated with the term of the concentration ability; it is later defined as short-term, several minutes of continuous stimuli, acting together and restricting attention with selective recording of relevant features of the given situation (cf.Sturm, 1990).
Tasks which require a **divided attention** must include at least include two sources of stimulation and these stimuli must be considered in parallel with each

other, and so may react to relevant impulses occurring simultaneously or sequentially. For example , if a motorist is driving his car through overcrowded streets in rush hour, and in this case enters into a discussion with the co-driver. If these stimuli encounter the senses at a great rate, it most likely that mistakes will occur: the performance ability is therefore decreased.
This function is the subject of the present training program.

When we talk about **vigilance** we refer to attention over long periods of time with small impulse density; as in the case of Stimuli relevant to high temporal impulse density, then one speaks of **continuous attention**.

The attention compared to relevant environmental stimuli is dependent on internal *variables in the organism* (physiological status, cognitive processes, emotions) and external factors (impulse strength, contrast, strength of colour, delineation technique, spatial relationship and so forth).
Attention can be focused automatically which is non-random through especially intense or novel impulses (with high information content) by a orientation reflex - cognitive processes modulate the current *attention status* through thoughts, motivations and interest. In particular the selectivity of attention is maintained(or not maintained) in a controlled manner constantly by emotional evaluations and through motivational processes.

Empirical investigations to recovering with laterally presented Stimuli material such as with split-brain patients, may put a special relevance on the right hemisphere concerning control and maintaining close elementary activation processes (cf.Sturm et al., 1994), although all neurological patients of attention troubles of different kind and markedness may be effected.
Due to investment and research in numerous brain fields and structures, the attention system shows a special *vulnerability* after every cerebral stroke and dysfunktion.

In the psychological performance diagnostic, in particular in clinical-neuropsychological diagnostic, tests have a firm place for the attention examination. The attention fields mentioned at the beginning can be separated diagnostically through different tasks. In addition to paper and pencil tests, the test batteries offer a differentiated picture of faulty functions for the attention examination in the Wiener debugging aids or according to Zimmermann & Fimm (1989).

Attention disorders with children are defined according to the diagnostic and statistical manual of psychological disorders (DSM III)
(Lauth & Schlottke, 1988) as a development inadequacy, lack of attention, impulsiveness and hyper activity.
In diagnostic practice the appraisal of attention mostly occurrs through "surface

parameters" like

- the required time,
- the number and kind of the mistakes,
- the developmennt of mistakes depending on time or
- the processed amount of the submitted material in relation to overcoming of defined tasks.

The advantages of a such diagnostic procedure lies in the extraction of measurable variables, that both intra- (illness process, therapy evaluation) and allow inter-individual arrangements (depending on the values of a default user group).
Especially in the last decade, the efforts have clearly increased to help with the problems of attention through cognitive training, and in particular with adult patients (Säring, 1988). Just after cerebral damage a great rehabilitation requirement exists as 80% of the brain damage leads to attention and concentration problems (Poeck, in 1989,Van Zomeren & Brouwer 1994).

The sectionsAim of the Training as well as Target Groups supply further information.

2.2 Training aim

More recent results in research argue for a differential approach to training, which target specific problems in attention. The reason for this is that not all unspecific and less theoretically guided attention training programs have been sucessful in all the areas, relating to attention problems and disturbances.(Gray & Robertson, 1989; Sohlberg & Mateer, 1987; Poser et al., 1992; Sturm et al., 1994; Sturm et al., 1997).

Variable objectives in this RehaCom-procedure are particularly for divided attention performance. However, in addition there are also trainging models designed for a general improvement in reaction time to be expected. There are also particular models for testing the ability to match visual and acoustic information in parallel with eachother and also the ability to seperate this information from irrelevant information is tested.
Despite that adaptive performance regulation is to be seen in each accumulative level, interference contingent patients will not be overstrained. The training - just like all cognative tasks - after a set time also establishes the duration of attention required.

Experience shows that performance improvements with computer supported training or more attention components are expected, in particular, in the post

acute phase after the stroke.

Along with the functional training offered by the work with the computer through systematic performance assessments for the patient. The patient also has the chance to improve self-perception and thereby the optimal allocation of the program's attention resources are fully used.

Therapeutically, it is favourable, that along with the confrontation of existing deficiency information interference and individual *Coping and Compensation strategy* development; for example the prevention of particular **stresses** or the use of external help by association with specific standard sitautions. Here the relatives should also be included.

The improvement of attention offers the basis for training targets with respect to other cognitive functions and is also connected with the treatment of disturbances in memory of elemental significance (recording of information as a requirement of storage).

On the basis of results of inputs - resp. the progressive diagnostic, it should be decided if the trainings system **Divided Attention** (DA) alone or if it should be used in conjunction with other systems. In most cases it would be considered important and favourable when a basic training in attention is used at first. (e.g. the RehaCom - System **Attention and Concentration**) In this way, the discussed system can be seen as specific practice system.

2.3 Target Groups

Disturbances in Attention *are caused most frequently by neurological performance deficiencies, after brain damage to different areas or sources in the organic tissue of the brain* (Van Zomeren & Brouwer, 1994). They occur in approx. 80% of patients after strokes, brain/cranium trauma, impairments to the brain of undetermined origin (e.g. following chronic alcohol abuse or intoxification), as well as other illnesses which effect the central nervous system.

Conceptually, it is assumed that different functions in attention can be selectively damaged. Brain damage of undetermined origin after traumatic or **hypoxic aetiology** leads to mostly unspecific deficiencies in attention, like rapid fatigue, increase in the need for sleep, and a general loss of motivation, whilst after localised strokes, for example of a vascular nature, specific disturbances in attention are often to be observed. According to the basic principles strokes in the cortexareale can lead to impairments in attention. After injuries to the brain stem, in the region of the reticular formation and parietal right sided injuries, problems are very noticeable in periodic and tonal alertness, as well as in vigilance. On the other hand, left sided parietal injuries damage the selective

attention services earlier; in particular in the case of tasks in which decisions must be made between several stimulating or reflex alternatives (Covert shifts of Attention) (cf.,Sturm1990).

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

In everyday life, there are numerous situations in which divided attention is required (budgeting, traffic, social communication 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 lacking in cognitive flexibility.
Also the problems described as *interference vulnerability* or *increased disturbances in control*, which are often to be observed after cerebral damage, 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.

Having accepted the assumptions of particular deficits of the different aspects of attention , one should also consider the possibility to train for these particular functions.

Present procedure is in particular suitable for difficulties in divided attention.

Using the premise of maximum specificity and to achieve as high as possible efficiency in the training , one should precede with the preparation of the therapy plan with computer-assisted procedures, a differentiated singular *neuropsychological* diagnostic.

The procedure **divided attention** was examined with other Rehacom procedures in two controlled studies with stroke and cranium brain trauma patients: Puhr (1997), Regel & Fritsch (1997); it showed significant improvements in the raised parameter resulted in Prae-post-comparison.

The application with children from 10th year/grade without important intellectual development challenges is possible; this is based on previous experiences.The procedure supports application in children, when instructions are used for child patients younger than or just 14 years of age.

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- T -

- V -