HASOMED

RehaCom®

Cognitive therapy

Divided Attention 2

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HASOMED RehaCom®

Cognitive therapy

by Hasomed GmbH

This manual contains information about using the RehaCom therapy system.

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

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

User assistance information:

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

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

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1 Training description

1.1 Training task

When using the Divided Attention 2 module, the patient drives a car and has to pay attention to the passing scenery and the dashboard of the car. Furthermore he or she has to respond to acoustic information on the radio. Initially, the patient only has to regulate the speed of the car. Later, with an increasing level of difficulty, more tasks are added, which expect reactions of other attention levels.

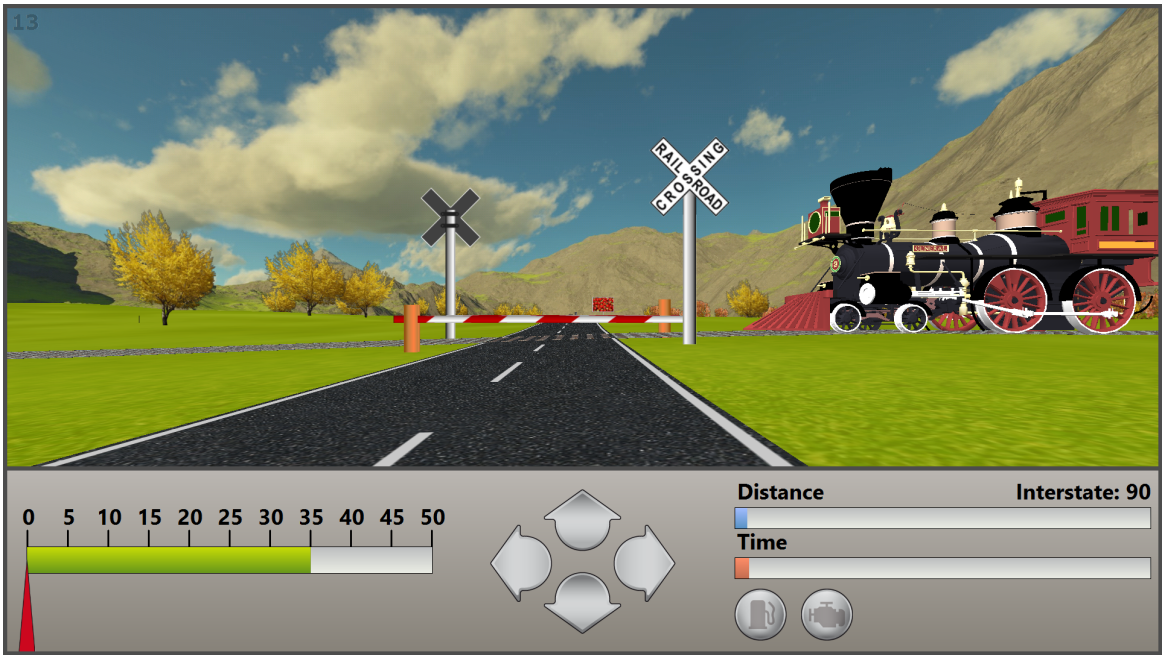

Fig. 1: View of training screen

Fig. 2: View of training screen with paramater "Cockpit view"

On the screen, the patient can see a simulation that includes the car's dashboard and a scene through the windshield (Fig. 1). On the left side of the dashboard is the speedometer to display the speed. In the speedometer is a green area, which marks the acceptable speed. Underneath the green area is a red arrow, which indicates the current speed. The red arrow must always be in the green area of the speedometer. To speed up the car, the up arrow has to be pressed. To slow down the car, the down arrow has to be pressed. On the right side of the dashboard, the distance driven and the elapsed time are displayed. The goal is to drive a certain distance in a limited time. It is important to ensure that the bar for the distance (blue bar) is always ahead of the bar for the elapsed time (red bar). A level is finished when the time has expired or the distance to be driven has been reached.
The car always moves on the road in a determined track (in curves too), therefore the patient is not required to keep the car on the road.

When the car is moving, irrelevant and relevant stimuli appear to move closer towards the patient. Irrelevant stimuli include trees, bushes, pedestrian crossings **without** waiting pedestrians, open railroad crossings and green traffic lights. Irrelevant stimuli do not require a reaction from the patient. Relevant stimuli do require a reaction from the patient. In addition to the relevant and irrelevant visual stimuli, Divided Attention 2 also uses relevant and irrelevant acoustic stimuli. The following chart shows the relevant stimuli and the reaction they require. In the evaluation of a level, only relevant objects and relevant acoustic stimuli are considered.

Relevant visual/acoustic stimuli	**Description / necessary reaction**

Traffic sign with speed limit (from level 1)	If the new maximum speed is below the current maximum speed, the patient has to slow down to the new maximum speed **before** reaching the traffic sign. If the new maximum speed is higher than the current maximum speed, the patient has to wait until passing the traffic sign to speed up. Only those reactions to the speed limits are considered, which are below the maximum speed of the level (up to level 2 - 60 mph, from level 3 - 80 mph). Each transgression of the allowed speed limit is a mistake. When exceeding this speed, a red arrow (down arrow) flashes on the dashboard to inform the patient to reduce its speed. If the acoustic stimuli setting is enabled, an acoustic warning sounds and reminds the patient to slow down. If the patient has not slowed down the car after five seconds, a new error for exceeding the speed limit is counted. In case the patient stops on a track for no apparent reason, a red arrow (up arrow) flashes and a honking signal sounds. A stopping of the car will never be counted as an error.
Acoustic request "turn left/ turn right" (arrow left/right) flashes in red color (from level 3)	When prompted to turn, the patient has to press the arrow for the appropriate direction **before** reaching the intersection to activate the turning signal. After pressing an arrow key, the particular arrow flashes in green. The turning signal is deactivated automatically after the car turns. When the request to turn comes, the car has to slow down to 25 mph before reaching the intersection. Up to level 6, the car slows down automatically before the intersection.

Indicator light refueling (from level 4)	When the red indicator light for refueling flashes, the patient must press the OK button within 6 seconds. If he/she does not press the OK button, the car will stop and the patient can continue driving by pressing the up arrow.
Indicator light oil pressure (from level 8)	When the red indicator light for oil pressure flashes, the patient must press the OK button within 6 seconds. If he/she does not press the OK button, the car will stop and the patient can continue driving by pressing the up arrow.
Additional attention level (with police car from level 9)	This optional stimuli can be enabled in the parameter menu. Beginning at level 9, the police car appears at certain intervals in the rearviewmirror. The patient must stop the car within 6 seconds. If the patient manages to stop the car in time, the blue light of the police car gets turned off and the patient may go on its ride. If the car does not stop in time, the police car passes and an error for the patient is counted.
Acoustic traffic news (from level 11)	During the ride, traffic news for various highways can be heard as though from a radio. The patient must press the "+" button when traffic news about a certain highway is heard. Before each level, the patient is informed which highway to listen for. After the beginning of the announcement the patient has 10 seconds to react to the traffic news.The name of the highway is called within the announcement after 4 to 5 seconds. The name of the highway the patient has to react to is always displayed on the right side, above the indicator for the distance traveled.
Railroad crossings (from level 13)	Sometimes during the ride a railroad

	crossing is crossed. When the railroad crossing is closed, the car must be stopped before reaching it. After opening the barriers, the patient can accelerate the car again.
Pedestrian crossings (from level 15)	At pedestrian crossings, if a pedestrian is standing on the side of the road, the car must be stopped before it reaches the pedestrian crossing. The patient may only go on once the pedestrian has crossed the road.
Traffic lights (from level 17)	In front of some intersections are traffic lights. If the traffic light is red, the patient must stop in front of it. The patient may only go on once the lights turn green.
Stop signs (from level 19)	If there is a stop sign next to the road, the patient has to stop before reaching the sign and then the ride can be resumed immediately.
Obstacles (from level 21)	On some roads, the patient encounters obstacles during the drive (cows, deer or similar). It must be stopped before the obstacles. Once the obstacle is gone, it can be continued.

Tab. 1: Tasks during training

The RehaCom module Divided Attention 2 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 current training level with all the appropriate instructions to complete the task is started.

This module can also be used without the RehaCom keyboard.

1.2 Performance feedback

At too high speed a red arrow (arrow down) flashes. Unless a traffic news is heard, acoustic feedback is given to tell the patient to slow down the car. If the "Plus button" is not pressed when relevant traffic news sound or if the "Plus button" is pressed

when irrelevant traffic news sound, the identifier of the relevant highway flashes up red briefly. After a correct reaction, the name of the highway flashes up green. Overrun obstacles and closed railroad crossings are covered with a crash sound.

After processing a level, the following mistakes are mentioned:

- driven too fast: x times
- pressed no button in case of relevant traffic news: x times
- pressed a button in case of irrelevant traffic news: x times
- not flashed: x times
- flashed wrongly: x times
- not stopped at pedestrian crossing: x times
- not stopped at railroad crossing: x times
- overlooked an obstacle on the road: x times
- overlooked a red traffic light: x times
- overlooked a stop sign: x times
- not stopped for a police car: x times (from version 6.2)
- indicator light for refuelling missed: x times (from version 6.3)
- indicator light for oil pressure missed: x times (from version 6.3)

or

Sorry, you did not manage the distance in the given time.

1.3 Levels of difficulty

The module works adaptively. All in all 22 levels were validated. The level of difficulty varies within the training by increasing the attention level and by changing the stimulus interval. In the following chart the allowed speed limits and the average number of stimuli per route are summarized. The course of the road from the curve/ intersection to the next curve/intersection is called a route. Starting with RehaCom version 6.0, 5 mph tolerance to the speed limit are assured to the patient, before a speed violation is considered as an error.

- **Level no. :** number of the respective level
- **max. v**: maximum speed limit on the whole distance
- **rel. v-signs**: number of the relevant speed signs per distance
- **v** ∅: average speed to drive, to achieve the whole distance in the given time
- **Stimulus interval**: average distance of the stimuli within a distance
- **Distance info turning signal before intersection**: indicates the distance to the intersection, until the acoustic and visual information to turn is reproduced
- **auto. v-reduct. at intersection**: When the information to turn at the intersection is given, one must reduce the speed to a maximum of 40km/h / 25 mph until the intersection. Up to level six, breaking happens automatically.

From level seven, the patient must slow down the car by him/herself.

- **Traffic news**: average number of traffic news per distance
- **Railroad crossings**: average number of railroad crossings per distance
- **Pedestrian crossings**: average number of pedestrian crossings per distance
- **Traffic lights**: average number of traffic lights at the end of a distance
- **Stop signs**: average number of stop signs at the end of a distance
- **Obstacles:** average number of obstacles per distance
- **No. differ. cars (oncoming traffic):** number of different car brands, which are visible as oncoming traffic
- **Min. duration until the next oncoming traffic:** minimum indifference between two cars, which are visible as oncoming traffic
- **No. houses:** total number of houses, which are distributed in the respective level of difficulty
- **Advertisement / Distance:** average number of billboards next to the road
- **Min. duration until police car:** minimum time differences between the appearing of the police cars in the rear view mirror (from vision 6.2)
- **Min. duration until indicator light refueling:** minimum time difference between the flashing of the indicator light for refueling +/- 60 seconds (from Version 6.3)
- **Min. duration until indicator light oil pressure:** minimum time difference between the flashing of the indicator light for oil pressure +/- 60 seconds (from Version 6.3)

Level no.	max v [km/h] / [mph]	∅ v [km/h] / [mph]	rel. v-signs [-]	Stimulus interval [-]	Distance blink info before intersection [-]	auto. v - reduct. at Intersections [-]	Traffic news [-]	Railroad crossings [-]	Pedestrian crossings [-]	Traffic lights [-]	Stop signs [-]	Obstacles [-]
1	60 /35	40 /25	2	high	--	--	0	0	0	0	0	0
2	60 /35	40 /25	2	low	--	--	0	0	0	0	0	0
3	80 /50	40 /25	2	high	high	yes	0	0	0	0	0	0
4	80 /50	40 /25	2	low	high	yes	0	0	0	0	0	0
5	80 /50	55 /35	2	high	low	yes	0	0	0	0	0	0
6	80 /50	55 /35	2	low	low	yes	0	0	0	0	0	0
7	80	55	2	high	high	no	0	0	0	0	0	0

8	80/50	55/35	2	low	high	no	0	0	0	0	0	0
9	80/50	55/35	2	high	low	no	0	0	0	0	0	0
10	80/50	55/35	2	low	low	no	0	0	0	0	0	0
11	80/50	55/35	1	high	low	no	2	0	0	0	0	0
12	80/50	55/35	1	low	low	no	2	0	0	0	0	0
13	80/50	55/35	1	high	low	no	2	1	0	0	0	0
14	80/50	55/35	1	low	low	no	2	1	0	0	0	0
15	80/50	55/35	1	high	low	no	2	0,5	1	0	0	0
16	80/50	55/35	1	low	low	no	2	0,5	1	0	0	0
17	80/50	55/35	1	high	low	no	2	0,7	0,7	0,8	0	0
18	80/50	55/35	1	low	low	no	2	0,7	0,7	0,8	0	0
19	80/50	55/35	1	high	low	no	2	0,7	0,7	0,2	0,6	0
20	80/50	55/35	1	low	low	no	2	0,7	0,7	0,2	0,6	0
21	80/50	55/35	1	high	low	no	2	0,4	0,4	0,3	0,3	0,5
22	80/50	55/35	1	low	low	no	2	0,4	0,4	0,3	0,3	0,5

Tab. 1: Levels of difficulty Part 1

Level no.	No. of different cars (oncoming traffic) [-]	min. duration until the next oncoming traffic [s]	No. houses[-]	Advertisement / Distance [-]	min. duration until police car (from Version 6.2) [s]	min. duration until indicator light refueling (from version 6.3) [s]	min. duration until indicator light oil pressure (from version 6.3) [s]
1	0	-	3	0	-	-	-
2	0	-	4	0	-	-	-
3	0	-	5	0.2	-	-	-
4	0	-	6	0.2	-	120	-

5	1	100	7	0.4	-	120	-
6	1	100	8	0.4	-	120	-
7	1	80	9	0.6	-	120	-
8	2	80	10	0.6	-	120	180
9	2	70	11	0.8	90	120	180
10	2	70	12	0.8	90	120	180
11	3	60	13	1.0	80	120	180
12	3	60	14	1.0	80	120	180
13	3	50	15	1.2	70	120	180
14	4	50	16	1.2	70	120	180
15	4	40	17	1.4	60	120	180
16	4	40	18	1.4	60	120	180
17	5	30	19	1.6	50	120	180
18	5	30	20	1.6	50	120	180
19	5	20	21	1.8	40	120	180
20	6	20	22	1.8	40	120	180
21	6	10	23	2.0	30	120	180
22	6	10	24	2.0	30	120	180

Tab. 2: Levels of difficulty Part 2

1.4 Training parameters

Specific settings for the training module can be adjusted (see Fig. 3). This section describes each setting and explains how to adjust them.

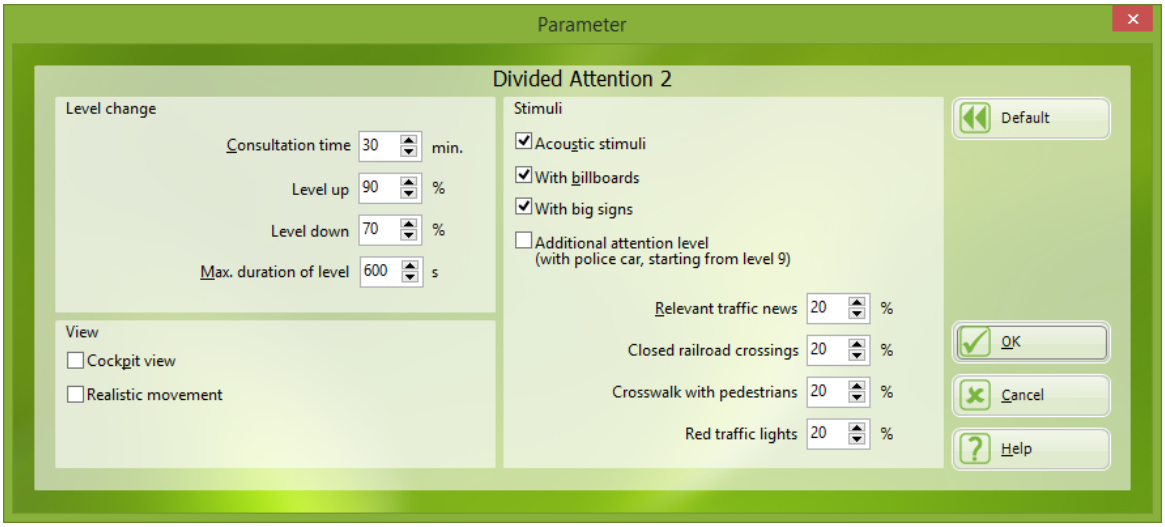

Fig. 3: Parameter menu

Duration of session:
We recommend a length of 25–30 minutes.

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.

Max. duration of a level:
The maximum duration of the work in a level is set. On the basis of this duration and the given average speed (see Tab. 1 Levels of difficulty), the way to be driven is calculated.

Acoustic stimuli:
The module "Divided Attention 2" can be trained without acoustic stimuli. If the parameter "Acoustic stimuli" is disabled, all traffic news and acoustic suggestions are omitted, as well as levels 11 and 12, because these levels only add the traffic news as a new stimulus.

With billboards:
On the left side and right side of the road are billboards. The number of billboards varies, depending on the level of difficulty (see Tab. 1 Levels of difficulty).

With big signs:
To ensure a better visibility of the traffic signs, they are viewed 1.5 times bigger as default.

Additional attention level (with police car starting from level 9):
Optionally, a police car can be set as an additional visual stimulus. Starting with level 9, the police car appears from time to time in the rear view mirror.

Relevant objects, relevant acoustic stimuli:
The percentage can be determined for relevant traffic news, closed railroad crossings, crosswalks with pedestrians and red traffic lights. The more relevant objects are used during training, the higher is the stress level for the patient to accomplish it in time.

Cockpit view:
The items of the speedometer are shown in a realistic representation when using the cockpit view. This display is suitable for patients with a high performance level. The cockpit view is only available for a screen resolution of 1024 x 768 pixels or higher.

Realistic movement:
The user's field of vision is adapted to the road gradient to provide the patient with a more realistic driving experience.

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

Current level of difficulty	1
Consultation time	30 minutes
Level up	90
Level down	70
Max. duration of level	600 s (10 min)
Acoustic stimuli	Enabled
With billboards	Enabled
With big signs	Enabled
Additional attention level (with police car starting from level 9)	Disabled
Relevant traffic news	20 %
Closed railroad crossings	20 %
Crosswalk with pedestrians	20 %
Red traffic lights	20 %
Cockpit view	Disabled
Realistic movement	Disabled

Tab. 3: Standard parameters

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
Distance	Distance traveled in comparison to the whole distance given in %
Correct level %	Correct reactions as a percentage of all reactions in the level (see "formula to calculate Correct level %)
Stimuli	Number or relevant stimuli
Correct	Number of correct reactions to relevant stimuli
Correct %	Correct reactions to relevant stimuli in %
Mistakes	Number of incorrect reactions to stimuli
Omissions	Number of missed reactions to relevant stimuli
Omissions %	Missed reactions to relevant stimuli in %
No. too fast	Number of exceeding the permitted speed limit (without omissions speed limit)

Omissions speed limit	Number of exceeding the permitted speed limit in case of relevant speed changes
Mistakes indicator	Use of the wrong turning signal when turning at an intersection
Mistakes traffic news	Number of reactions to irrelevant traffic news
Omissions indicator	No turning signal when turning at an intersection
Omissions traffic news	Number of non-reactions to relevant traffic news
Omissions railroad crossings	Number of non-stops at closed railroad crossings
Omissions pedestrian crossings	Number of non-stops at crosswalks with pedestrians
Omissions traffic light	Number of non-stops at red traffic lights
Omissions stop signs	Number of non-stops at stop signs
Omissions obstacles	Number of non-stops in front of obstacles
Omissions police cars	Number of non-stops for a police car
Omissions refueling	No reaction to a flashing indicator light for refueling
Omissions oil pressure	No reaction to a flashing indicator light for oil pressure
Train. time task	Effective consultation time in h:mm:ss
Breaks	Number of breaks caused by the patient

Tab. 4: Result data

Formula to calculate "Correct level %":

"Correct Level %"= ("Number of correct reactions" *100)/ ("Number of reactions in total")

"Number of reactions in total" =

+ Number of correct uses of the turning signal
+ Number of incorrect uses of the turning signal
+ Number of non-uses of the turning signals
+ Number of stops at relevant pedestrian crosswalks
+ Number of non-stops at relevant pedestrian crosswalks
+ Number of stops at relevant railroad crossings
+ Number of non-stops at relevant railroad crossings
+ Number of stops in front of obstacles
+ Number of non-stops in front of obstacles
+ Number of exceeding the speed limit
+ Number of non-reactions to relevant speed changes
+ Number of correct reactions to relevant speed changes
+ Number of stops at red traffic lights
+ Number of non-stops at red traffic lights
+ Number of non-stops at stop signs
+ Number of stops at stop signs

+ Number of correct reactions to relevant traffic news
+ Number of incorrect reactions to relevant traffic news ("+" button not pressed)
+ Number of reactions to irrelevant traffic news ("+" button pressed)
+ Number of stops for police car
+ Number of non-stops for police car
+ Number of non-reaction to indicator light for oil pressure
+ Number of correct reactions to indicator light for oil pressure
+ Number of non-reactions to indicator light for refueling
+ Number of correct reactions to indicator light for refueling

"Number of correct reactions"

+ Number of correct uses of the turning signal
+ Number of stops at relevant pedestrian crosswalks
+ Number of stops at relevant railroad crossings
+ Number of stops in front of obstacles
+ Number of correct reactions to relevant speed changes
+ Number of stops at red traffic lights
+ Number of stops at stop signs
+ Number of correct reactions to relevant traffic news
+ Number of stops for police car
+ Number of correct reactions to indicator light for oil pressure
+ Number of correct reactions to indicator light for refueling

The parameter settings used during the training are displayed directly below the table. The graphical presentation of the results (e.g., percent correct, percent 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

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 automatical. With the registration of specific aspects of situations, active analysis processes are set in operation. Automatic processes operate in a smaller capacity in parallel. 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, an 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.

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