HASOMED

RehaCom®

Cognitive therapy

Reaction Behavior

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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 GmbH
Paul-Ecke-Str. 1
D-39114 Magdeburg

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

USA:
Pearson Clinical Assessment
19500 Bulverde Road, Suite 201
San Antonio, TX 78259-3701

Phone: 1-888-783-6363
www.pearsonclinical.com/RehaCom
rehacominfo@pearson.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.

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1 Training description

1.1 Training task

The training of the reaction behavior takes place close to reality by using thematically related objects as signals (for example, traffic signs, animals in the meadow, etc.). When certain objects appear on the screen, a specific button on the patient keyboard must be pressed as quickly as possible (relevant stimuli). There are also irrelevant signals ("other" objects) which should not be reacted to. The meaning of the objects is usually associated with the reaction button in order to minimize the memory components. The following assignments are defined:

- Objects that have directional information to the right or left (e.g., traffic signs with arrows, animals with a line of sight, etc.) are answered with the "right" and "left" arrow keys, respectively.
- Depending on the task, you can react to other objects with the OK button or the "up" and "down" arrow keys.

Each task has 2 phases:

- the preparation phase, and
- the reaction training phase.

During the preparation phase, the patient makes him-/herself familiar with the task (see Fig. 1). The patient has to memorize which key has to be pressed in relation to the stimulus being presented. The irrelevant stimuli, which are used later in the training, are not shown. The patient ends the preparatory phase by pressing the OK key.

Fig. 1: Preparation phase at Level 6

The reaction training phase then follows (see Fig. 2). After appearance of an object, the key assigned to the signal must be pressed as quickly as possible in case of relevant stimuli. To minimize the memory component, the signal to key relations are always visible on the screen. Don't react to irrelevant signals. Wrong decisions are reported by audible and / or visual feedback. The task is over when the number of objects defined with number of stimuli has been shown.

Fig. 2: Reaction training at level 6. On the right the key indicator is continuously shown. The patient has to press the 'OK' key.

There are four types of errors which can be made:

- reaction too late (Reaction time > maximum reaction time),
- no reaction to a relevant stimulus,
- incorrect reaction (incorrect key pressed in reaction to a relevant stimulus or pressing a key in reaction to an irrelevant stimulus) and
- anticipations (too early reactions before the minimum response time of 150 ms).

Anticipations are not included in the level evaluation, that means, only the stimuli are used to calculate the ascent / descent criterion that were not anticipated.

1.2 Performance feedback

With set standard parameters, an acoustic signal sounds if the response is incorrect. This can be optionally deactivated with the parameter "Feedback acoustic" in the parameter menu.

In addition, at this point, the visual feedback can be activated, which is realized by a colored frame around the displayed stimulus and / or the coloring of the pressed button on the screen. The feedback color depends on the type of error (yellow in case of interstimulus reaction and too late reaction, red in case of reaction with wrong key or irrelevant stimulus).

Fig. 3: Visual feedback in case of a reaction with wrong key

Each time an error type occurs, the error and the associated feedback are explained by an inserted instruction screen.
Correct reactions are not acknowledged by separate feedback. Also in anticipations, which are not included in the evaluation, there is no feedback, so as

not to give the patient the impression that quick reaction will be punished.
At the end of each task, the patient is informed about the quality of his task processing. At the same time reference is made to the difficulty of the next task.

1.3 Levels of difficulty

The module works in an adaptive way. The levels of difficulty are organized around the following criteria:

- Utilization of 3 types of tasks,
- Use of simple, choice and multiple-choice reaction,
- central and peripheral (distributed randomly throughout the training field) processing of signals and
- Use of relevant and irrelevant signals

In **task type 1**, the next stimulus only appears after a reaction of the patient. **The patient determines the processing speed**. After a reaction, a stochastic time passes until the next stimulus, determined by the parameter interstimulus interval +/- 50%. A relevant object remains visible until the reaction. An irrelevant object disappears after the elapse of time.

In **task type 2**, the stimuli appear in an established time period (set up in the parameter menu). **The computer establishes the time period.**

In **task type 3**, the time between stimuli alters in an adaptive way, which is **dependent on the quality of the patient's reactions**. The period between presentation of stimuli decreases after correct reactions and increases after incorrect reactions. There is no change in the time period if the patient does not react to an irrelevant stimulus. During a level of this task type, there are higher demands on the reaction time and the patient's ability to discriminate between the signals.

There are 16 different levels of difficulty clearly defined (see Tab. 1).

Level	Type	Reaction type	Irrelevant stimuli	Position
1	1	Single	No	Central
2	1	Single	No	Peripheral
3	2	Single	No	Central
4	2	Double	No	Central
5	2	Double	25%	Central
6	2	Triple	No	Peripheral
7	2	Triple	25%	Peripheral
8	2	Quadruple	No	Peripheral
9	2	Quadruple	50%	Peripheral

Level	Type	Reaction type	Irrelevant stimuli	Position
10	2	Double	50%	Central
11	2	Triple	No	Peripheral
12	2	Triple	50%	Peripheral
13	2	Quadruple	No	Peripheral
14	2	Quadruple	50%	Peripheral
15	3	Triple	No	Peripheral
16	3	Quadruple	No	Peripheral

Tab. 1: Structure of the level of difficulty

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.

Skip tutorial:
The integrated tutorial can be skipped by the therapist if necessary. Therefore, the lower corner button  or button 0 (zero) can be used.

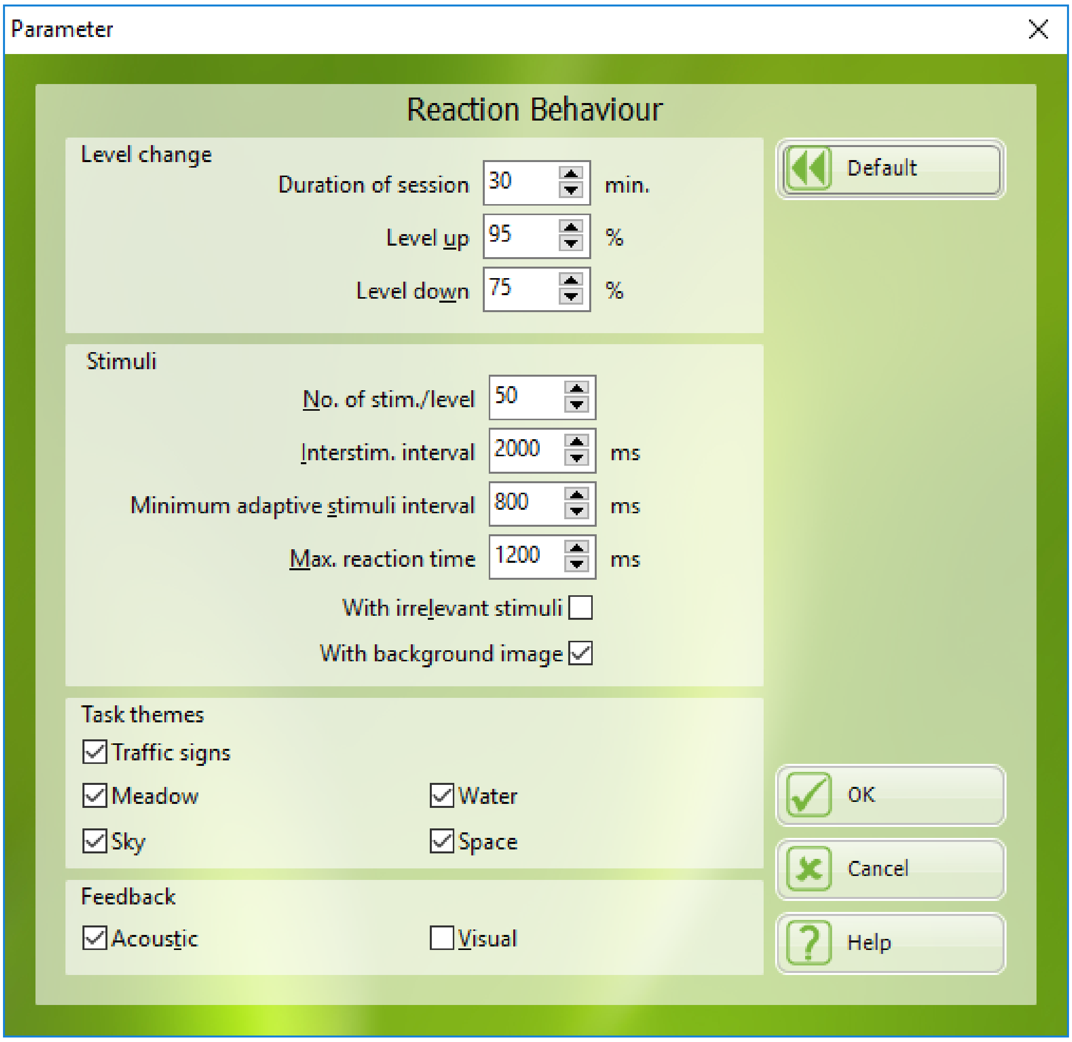

Fig. 4: Parameter menu

Duration of session:
A training period of 30 minutes is recommended.

Level up / Level down:
After completing a task of task type 1 (levels 1–2) or task type 2 (levels 3–14), a percentage value is calculated—the percentage of correct decisions in relation to the number of stimuli. The level increases when the percentage calculated exceeds the value for the "Level up" parameter. This value should be reduced if the client continues to have difficulties over a long period of time. Reducing the value for "Level up" could help maintain the patient's motivation. An increase in this parameter makes it more difficult to go to the next level.

For tasks that use task type 3 (levels 11–16), the decision to change the level of difficulty is based on the reaction times in the second half of the task. In the first half of the task, the patient has to react correctly so that the adaptive interstimulus interval is reduced to the value of the parameter “Minimum adaptive stimulus interval.” If the patient does not reach this limit, the parameter “Minimum adaptive stimulus interval” should be modified to match the patient’s ability. In the second half of the task, the patient has to maintain this performance level. Here the reactions with the correct key are rated as "correct", whose reaction time lies below the achieved stimulus distance (otherwise "omission") as well as below the maximum reaction time (otherwise "too late reaction"). If the percentage of reactions evaluated as correct is below the established percentage for "Level up," then the level of difficulty is increased for the next task. If the percentage correct is less than the established percentage for “Level down,” then the level of difficulty is decreased. If the percentage correct is between the values for “Level up” and “Level down,” then the level is repeated.

No. of stimuli/level:
The sum of the relevant and irrelevant objects shown in the course of a task is determined. When working in task type 3, the number of stimuli should not be less than 100, to ensure that the median stimulus interval is stabilized.

Interstim. interval (ms):
The parameters for the type of tasks have different meanings.
In the case of task type 1, the period between stimuli is calculated as the time of reaction by the patient up to appearance of the next stimulus. (period between stimuli = Interstimulus interval +/- 50%). In the case of task type 2, the period between stimuli is calculated as the time from the start of the first stimulus to the start of the second stimulus.
If there is no reaction to a relevant stimulus before the maximum reaction time has elapsed, it is evaluated as incorrect and the next stimulus appears.
In the case of task type 3, the initial time period between stimuli is the value for the interstimulus interval. After each correct reaction, the time period between stimuli is reduced by 5%, and when a reaction is incorrect or when there is no reaction to a relevant stimulus, the time period between stimuli is increased by 5%.

Minimum adaptive stimuli interval:
For tasks that use task type 3, the adaptive stimuli interval is used (see Levels of difficulty). If the patient reacts correctly, the stimuli interval is shortened. This leads to frustration of the patient, because a timely response to the following stimuli is hardly possible due to the continuously decreasing stimulus distance with correct processing. To avoid this frustration, a limit can be set for the minimum adaptive stimuli interval that is within the patient’s ability.

Maximum reaction time (ms):
For tasks that use task types 1 and 2, if a reaction occurs after the maximum reaction time has elapsed, then that reaction is evaluated as incorrect. For tasks that use task type 3, the maximum reaction time is used as the criterion for deciding whether the level of difficulty should be changed. The "Maximum reaction time" should be increased if the emphasis in the training is placed on the quality of the patient’s reactions and not on speed of the reactions which may act as a stress

factor. However, the parameter should be reset to the default value when the patient improves.
A decrease in this parameter acts as a stress factor.

With irrelevant stimuli:
When this parameter is enabled, both, relevant stimuli and irrelevant stimuli, are shown during some levels (see Levels of difficulty). When irrelevant stimuli appear during a level, the patient is supposed to not press any key.

With background picture:
The stimuli are presented in front of a thematically appropriate background.

Task topics:
Here, if required, individual topics for the visual presentation of the training tasks can be deselected.

Acoustic Feedback:
If there is an incorrect reaction, a warning tone can be heard. If there is more than just one patient working in the room, then the acoustic tones can cause interference and should be disabled. In this case, visual feedback should be enabled.

Visual Feedback:
Feedback for wrong reactions is realized by colored frames (see feedback). In general, the acoustic feedback should always be enabled.

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
Duration of session	30 min
Level up	95 %
Level down	75 %
No. of stim./level	50
Interstimulus interval	2000ms
Minimum adaptive stimuli interval	800ms
Maximum reaction time	1200 ms
With irrelevant stimuli	Disabled
Acoustic feedback	Enabled
Visual feedback	Disabled
With background picture	Enabled
Task topics	All Enabled

You are able to change the ***Side Orientation*** in the Clients menu: Clients -> Edit ->Tab: File -> Options field: Hemianopsia.

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	Sum of relevant and irrelevant stimuli
Stimuli rel.	Number of relevant stimuli
Stimuli irrel.	Number of irrelevant stimuli
Correct	Correct reactions to relevant stimuli in %
Mistakes total	Total number of incorrect reactions
Mistakes wrong key	Number of reactions with a wrong key
Mistakes delayed	Number of reactions after the max. reaction time has elapsed
Omissions	Number of relevant stimuli to which there was no reaction
Reac. interstim.	Number of reactions during interstimulus interval
Anticipations	Number of reactions before the minimum reaction time has expired
Median reac. time	Median for all reaction times to relevant stimuli in ms
Quartil1 reac. time	Reaction time quartile 1 in ms
Quartil3 reac. time	Reaction time quartile 3 in ms
Train. time task	Effective training time
Breaks	Number of breaks caused by the patient

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

For the parameters Quartil1 reac. time, Quartil1 reac. time and Quartil3 reac. time applies following: Only reactions to relevant stimuli (except anticipations) are used for the calculation.

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

2 Theoretical concept

2.1 Foundations

The Reaction Behavior module presupposes complex psycho-physiological performance skills which allow individuals to react in a specific manner to particular external stimuli. Phasic attention parameters have a big role to play in the response behavior.

Phasic activation is defined as the ability to rapidly increase the activation level for a subsequent reflex situation, rapid reaction 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 ability to focus 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).

The ability to focus one's attention is a fundamental prerequisite for a general capability with regard to different cognitive functions.

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.

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 stimuli,
3. Choice of the reaction, and
4. Activity of a motor program in reaction to the stimuli.

These processes are partially automatic; 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.

For every reaction, several stages can be distinguished:

- Increase of attention level in expectation of a stimulus
- Presentation of stimulus
- Latency phase
- Decision time

- Motor action

Reaction time is the description for the length of time between the presentation of a stimulus and the execution of a simple motor reflex. It consists of the **latency time** (duration of the excitement in the nervous system) and the **decision time** (duration of information processing) (Fröhlich, 1987).

The reaction rate is seen in connection with the rate of information processing, whose most frequent operation represents the investigation of simple and complex stimulus reaction experiments (Säring, 1988).

Münsterberg (1924) makes a distinction between ***simple- and multiple-choice reactions***.

- Simple-choice reactions refer to decisions where a reaction only to a relevant stimulus is expected even though several stimuli are presented.
- Multiple-choice reactions refer to decisions where one is expected to react differently to several relevant stimuli.

The reaction to relevant stimuli in a multiple-choice reaction is influenced by additional factors:

- Type of stimulus (acoustic, visual, thermal, etc.)
- The differentiation between type and degree of stimulus
- Rate of appearance of relevant stimuli
- The possibility of associative coupling between stimulus and reaction

Intellectual and practical activities are impaired by attention and concentration problems which can be expressed in reduced retention and processing capacity, reduced information processing speed, rapid fatigue, and above all an increase in distractibility.

Attention deficit disorders include measurable factors such as reaction slowdown or an increased number of errors in different tasks. Attention deficit disorders after brain damage are the most frequent neuropsychological performance deficits after insult to the brain (Van Zomeren & Brouwer, 1994). Impairments of reaction capacity are found in approximately 70% of the patients; most of all, a slowing of the reaction or information processing speed is observed in patients suffering from brain damage (Poeck, 1989; Sturm, Dahmen, Hartje, & Willmes, 1983; Säring, 1988; Benton, 1986). Regel, Krause, and Krüger (1981) see the cognitive slowing as a basic symptom of cerebral impairment.

In a psychological performance diagnostic, in particular in clinical-neuropsychological assessment, tests for the examination of attention capabilities are essential (Zimmermann & Fimm, 1989). The aspects of attention mentioned before can be distinguished diagnostically by assigning different tasks to each of them.

Reaction behavior is often dealt with in connection with determination tasks. The following parameters should be considered:

- the time needed,
- the number and kind of mistakes made,
- the development of mistakes over time, or
- the share of the jobs carried out in relation to all jobs given when coping with defined tasks.

The advantages of such a diagnostic procedure lies in the extraction of measurable variables, both intra-individual (development of the illness, therapy evaluation) as well as inter-individual comparisons (depending on the measurements of a normative group).

The sections Training aim and Target groups provide further information.

2.2 Training aim

The **Reaction Behavior** module is designed to improve the patient's **exactness and speed of reactions** in relation to a set of given visual stimuli. By using simple and multiple choice reaction tasks, the patient is trained to distinguish between the given stimuli and react quickly.

The patient should react as quickly as possible to a set of traffic signals; in this way the module reflects a high ecological validity. During this training – as a precondition for a reaction – the patient’s ability to focus on specific information and disregard irrelevant information (selective attention) is trained in the visual modality. The memory aspect of the module is minimized by the assignment of the signals to reaction keys on the RehaCom Keyboard, which are fixed, except for a few exceptions in training.

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 et al., 1994; Sturm, Willmes, & Orgaß, 1997). The module **Reaction Behavior** is also used for patients with deficits in selective attention without a general slowness of reaction.

Training with the **Reaction Behavior** module makes demands on a patient's cognitive flexibility and, through practice, can positively influence a patient's motor skills (and apraxia). Furthermore, as with all cognitive tasks after a certain length of time, demands are also put on the patient's continuous attention capabilities.

Experience shows (e.g. Fernández et al., 2012) that performance improvements with computer supported training or more attention components are expected, in particular, in the post-acute phase after a stroke.

In addition to the functional training, the computer gives systematic feedback to the patient which can improve the patient's self-observation and thus teach him or her how to cope with his or her attention resources. The patient also has the chance to improve self-perception and thereby the optimal allocation of the program's attention resources is fully used.

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.

On the basis of results of diagnosis, it should be decided if the **Reaction Behavior** module is used alone for therapy or in combination with additional modules, such as Attention & Concentration (AUFM), Divided Attention (GEAU), or Vigilance (VIGI).

2.3 Target groups

The use of this module is recommended for patients who suffer from diagnosed impairments to their reaction speed/safety which have been caused by disturbances to memory or lesions to the brain.

Impairments to reaction capacity can appear to some degree in all neurological diseases. This applies to attention deficits as well.

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).

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 phasic activation and selective attention.

Patients who suffer from a type of motor disability (e.g., partial paralysis) have the option to train their reaction speed with either the dominant or non-dominant hand, whichever is unaffected by the disability.

The demanding character of the traffic signals on patients who suffer from a strong dysexecutive syndrome (which occurs after injuries to the frontal area of the brain) can have a positive effect on their reaction capabilities.

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.

Before training with the Reaction Behavior module, patients with serious visual deficits should train using the appropriate visual training therapy module(s): Overview and Reading (ZIHL), Restoration Training (RESE), or Saccadic Training (SAKA). Patients who suffer from strong attention problems should first train with the RehaCom module Attention & Concentration.

The module uses child-friendly instructions for patients up to the age of 14.

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