HASOMED

RehaCom®

Cognitive therapy

Responsiveness

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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

The Responsiveness training module uses simple-, simple choice- and multiple-choice reactions for training a patient's reaction speed and accuracy. The training contains both visual and acoustic stimuli. After the appearance of a defined visual stimulus or the presentation of an acoustic stimulus, the patient is supposed to press a corresponding button on the RehaCom keyboard as quickly as possible.

Before starting the training, the speakers icon in the Windows notification area (usually the bottom right corner of the screen) can be used to regulate the volume according to the patient's needs. When the icon is selected, a slider appears, which can be changed. In the RehaCom program, check the volume in the RehaCom main window by pressing the **System** button, and then pressing the **Volume RehaCom** button in the System Parameter dialog box that opens up (see Basic RehaCom manual).

This is particularly important when using headphones. Loudspeakers often have a turning knob to regulate the volume.

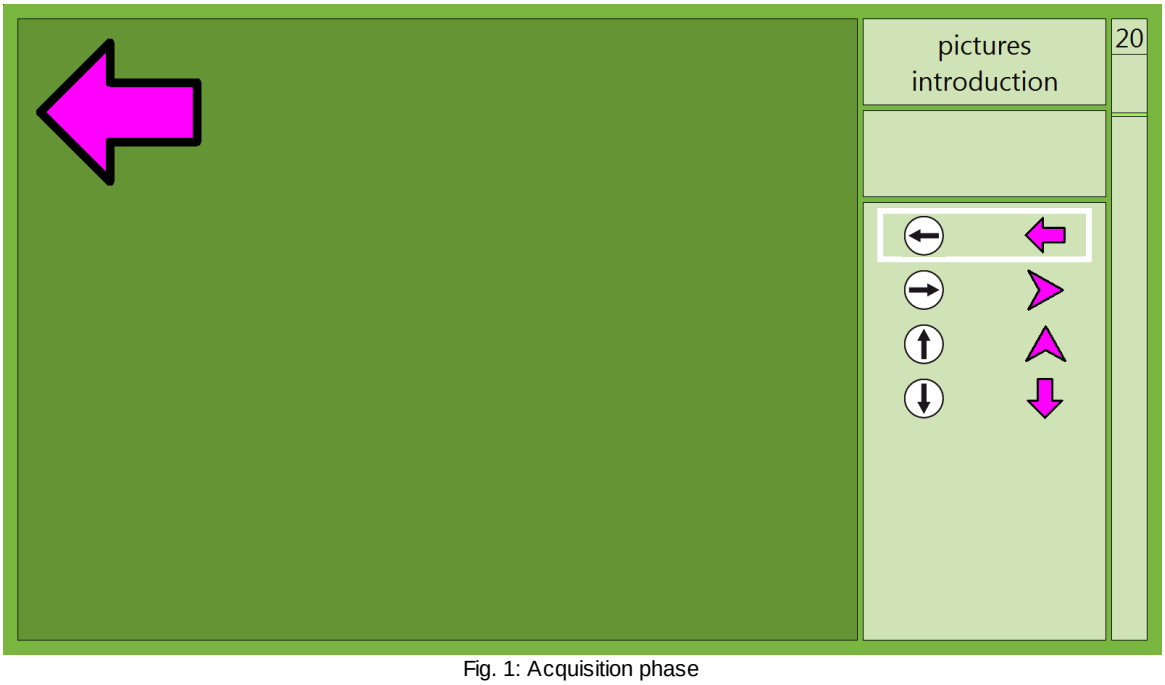

Fig. 1: Acquisition phase

Every task consists of 2 or 3 phases:

- the acquisition phase,
- the practice phase (if enabled in the Parameter menu), and
- the reaction training phase.

During the acquisition phase (see Fig. 1), the patient familiarizes himself with the specific reaction task. The patient memorizes the assignments of the relevant stimuli to the keys. Any irrelevant stimuli to be used in the training are not presented. The patient completes the acquisition phase by pressing the **OK** button.

If the Practice option is enabled in the parameter menu, the acquisition phase is followed by a practice phase. In this phase, all different stimuli are shown twice. The practice phase is like the training, except historical data (reaction times and qualities) are not registered. The practice phase is completed when the patient reacts correctly to all stimuli. After pressing the **OK** button, the actual training starts (see Fig. 2).

In the course of a task, the number of stimuli defined by the Training parameters is presented. After the appearance of a **relevant stimulus,** a certain button of the RehaCom keyboard has to be pressed as quickly as possible. To minimize the memory components, the stimulus/button combination is always visible on the side of the screen. If ***irrelevant stimuli*** appear, the patient should not react. Incorrect decisions are indicated by visual feedback.
If several patients train in one room, headphones should be used.

Fig. 2: Reaction training phase at task 1
On the right, the relevant stimuli and their corresponding buttons are displayed throughout the task. Not, the right arrow button has to be pressed.

The following types of errors are differentiated:

- reactions to irrelevant stimuli
- late or no reaction to relevant stimuli (reaction time is longer than the maximum reaction time),
- incorrect reaction to relevant stimuli (wrong button pressed).

Before every training task, instructions are given depending on the level, because each level of difficulty consists of specific tasks to perform (see Levels of difficulty). During the instruction phase, "Learning by doing" helps the patient to quickly learn the training task.

Key allocation:
Each button on the RehaCom keyboard corresponds to a key on the computer keyboard (see Tab. 1).

RehaCom Keyboard	Computer keyboard
Left arrow	Left arrow
Right arrow	Right arrow
Up arrow	Up arrow
Down arrow	Down arrow
OK (left)	Spacebar
OK (right)	Enter button
Minus "-" button	"-" button
Foot left	"Delete" button
Foot right	"Page down" button

Tab. 1: Key allocation

1.2 Performance feedback

The feedback occurs both visually and acoustically.

Visual feedback:
The following options are available for the visual feedback:

- ***INCORRECT***: The word "Incorrect" appears in a red field when the patient presses an incorrect button. If the patient does not react to stimuli after a certain period of time (2000 milliseconds[ms]), the phrase "Too Slow" appears.
- ***INCORRECT+CORRECT***: Depending on the quality of the reaction, the word "Correct" or "Incorrect" appears. If the patient does not react to stimuli after a certain period of time (2000 ms), the phrase "Too Slow" appears.
- ***Reaction times***: The reaction times of the last 10 stimuli are displayed as a bar graph. If the reaction was incorrect, the bar appears in red. This feedback can be irritating and should be used only for high-performance patients. Correct reactions within the maximum reaction time are displayed in blue; reactions above the maximum reaction time are displayed in yellow. A red bar appears for instances when no reaction occurs within the two seconds that the stimulus is displayed or when a reaction is incorrect.

- ***No*** visual feedback.

Additionally, a **performance bar** is available. With every correct reaction increases a white bar. When the bar reaches the green mark, the level of difficulty is increased in the next task. If the mark is not reached, the patient keeps on training with a task in the same level of difficulty.

At the end of each task, the patient is informed how many errors were made and whether he/she has to work faster or not in case of an insufficient reaction speed. At the same time it is referred to the level of difficulty of the next task.

Acoustic feedback:
After qualitative incorrect reactions, a warning signal will be heard. Correct reactions are not reported. If several patients train in one room and thus interferences are caused, the acoustic feedback should be turned off. Only the visual feedback should be used.
When a module with acoustic stimuli is used (e.g. module2), an acoustic feedback should always be avoided.

1.3 Levels of difficulty

The module works adaptively. The next task will start when the results of the previous task are below the set limits for the reaction rate and the error rate.

The levels of difficulty are based on the following criteria:

- Use of four level types,
- Use of simple-, choice- and multiple choice reactions,
- Central (fixed location) and peripheral (randomly distributed across the training field) stimulus presentation, and
- Use of relevant and irrelevant stimuli.

At ***level type 1 (new stimulus after reaction),*** the next stimulus appears only after the patient's reaction to the current stimulus or after 60 seconds as passed. ***The patient determines the processing speed.*** After the patient reacts to a stimulus, a new stimulus appears. A relevant stimulus is constantly displayed until the patient reacts. Irrelevant stimuli are not available in this type of level.

At ***level type 2 (constant stimulus interval),*** stimuli are shown in a fixed time interval (determined by the parameter stimuli interval). ***The computer determines the processing speed.***

At ***level type 3 (stochastic stimulus interval),*** the next stimulus is shown after a random interval. ***The computer determines the processing speed.*** After a

reaction, a stochastic interval determines when the next stimulus appears. It is determined by the parameter stimulus interval 0 to 75%. A patient can react to a stimulus until the set time for stimulus duration has elapsed.

*At **level type 4 (adaptive stimulus interval),*** the time between two stimuli changes ***adaptively in relation to the reaction quality.*** The stimulus interval is reduced when the patient reacts correctly and extended when the patient reacts incorrectly. There are significantly higher requirements on reaction speed rate and on discrimination ability.

Three stimuli modules are available for the therapist to choose from.

Module 1:
The simuli module 1 consists of 20 levels. In each level, five different tasks are always trained. No acoustic stimuli are trained and only level types 2 and 3 get applied (see Tab. 2 and Tab. 3). Each of the five tasks at a given level differ in the assignment of stimulus and keyboard key.

Task 1	Arrows are used as relevant stimulus, which match the direction of the key to which it's assigned on the RehaCom keyboard (associative link).
Task 2	The OK button is used in connection with a cross stimulus. When there are several relevant stimuli being presented, the arrow keys are also used, either with arrow stimuli as in task 1 or with a variation of the cross stimulus.
Task 3	Stimuli without directional information are used (e.g., circles, rectangles, and diamonds).
Task 4	Arrows are used as stimuli, which are contralateral to the arrows to which they are assigned on the keyboard keys.
Task 5	Stimuli with and without directional information are used without reference to arrows of the keyboard keys (no associative link).

Tab. 2: Descriptions of the 5 tasks (all of which are present in module 1).

Level	*Pictures relev.*	*Pictures irrel.*	*Sounds relev.*	*Sound irrel.*	*Sum stimuli*	*Foot-panel left*	*Foot-panel right*	*Level type*	*Position*
1	1	0	0	0	1	no	no	2	central
2	1	0	0	0	1	no	no	3	central
3	2	0	0	0	2	no	no	2	central
4	2	0	0	0	2	no	no	3	central
5	2	0	0	0	2	no	no	3	peripheral

6	2	1	0	0	3	no	no	2	central
7	2	1	0	0	3	no	no	3	central
8	2	1	0	0	3	no	no	3	peripheral
9	3	0	0	0	3	no	no	2	central
10	3	0	0	0	3	no	no	3	central
11	3	0	0	0	3	no	no	3	peripheral
12	3	1	0	0	4	no	no	2	central
13	3	1	0	0	4	no	no	3	central
14	3	1	0	0	4	no	no	3	peripheral
15	3	2	0	0	5	no	no	2	central
16	3	2	0	0	5	no	no	3	central
17	3	2	0	0	5	no	no	3	peripheral
18	4	0	0	0	4	no	no	3	peripheral
19	4	1	0	0	5	no	no	3	peripheral
20	4	2	0	0	6	no	no	3	peripheral

Tab. 3: Levels of difficulty using module 1.

Module 3:
The stimuli module 3 consists of 20 levels, each with just one task. All 4 level types are used as well as visual and acoustic stimuli (see Tab. 5).

Level	***Pic-tures relev.***	***Pic-tures irrel.***	***Sounds relev.***	***Sounds irrel.***	***Sum stimuli***	***Foot-panel left***	***Foot-panel right***	***Level type***	***Position***
1	2	0	0	0	2	no	no	1	peripheral
2	1	0	1	0	2	no	no	1	peripheral
3	2	0	0	0	2	no	no	2	peripheral
4	1	0	1	0	2	no	no	2	peripheral
5	1	0	1	0	2	no	no	3	peripheral
6	3	0	0	0	3	no	no	2	peripheral
7	2	0	1	0	3	no	no	2	peripheral
8	3	0	0	0	3	no	no	3	peripheral
9	2	0	1	0	3	no	no	3	peripheral
10	1	0	2	0	3	no	no	3	peripheral
11	4	0	1	0	4	no	no	2	peripheral
12	3	0	0	0	4	no	no	2	peripheral
13	4	0	0	0	4	no	no	3	peripheral
14	3	0	1	0	4	no	no	3	peripheral
15	2	0	2	0	4	no	no	4	peripheral
16	4	0	1	0	5	no	no	2	peripheral

17	4	0	1	0	5	no	no	3	peripheral
18	4	0	1	0	5	no	no	4	peripheral
19	3	0	2	0	5	no	no	3	peripheral
20	3	0	2	0	5	no	no	4	peripheral

Tab. 4: Levels of difficulty using module 3.

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.

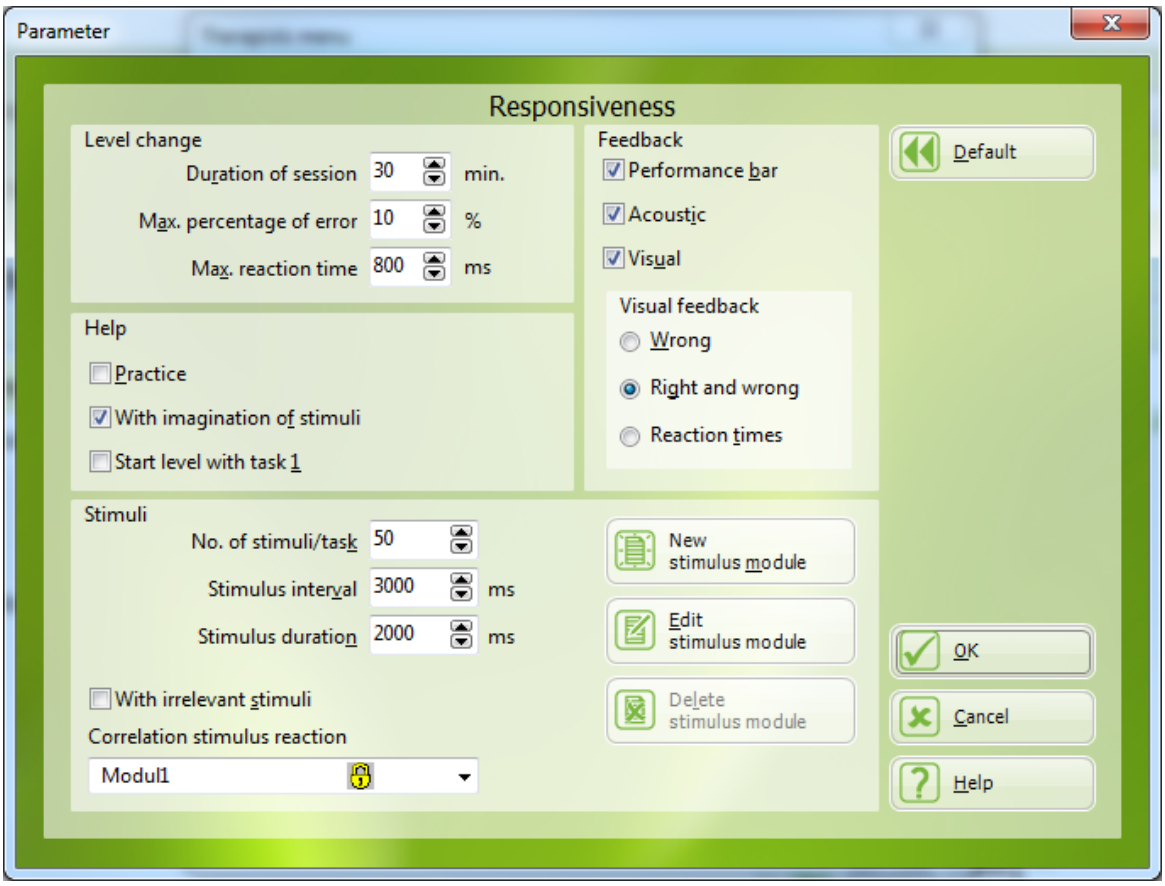

Fig. 3: Parameter settings

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

Max. percentage of error:
If the "maximum percentage of error" was exceeded during the last consultation, the patient continues training in the same level and with the same task number. The next task with a higher level of difficulty is used if maximum percentage of error and maximum reaction time have not been exceeded.

Max. reaction time (ms):
In addition to the "maximum percentage of error," the "maximum reaction time" is used as a criterion for increasing the level of difficulty. After the patient completes a task, the median value of the reaction times is calculated. If the median value is above the maximum reaction time, the training continues with the same task regardless of the number of errors made.

Help:
For stimulus reaction training, various help options are available. When the box **Practice** is marked, the patient passes through every task in practice mode first. The practice mode is like training, but without saving the results.
When choosing "With imagination of stimuli," all relevant stimuli of the task are represented successively with the corresponding button before training on a particular task begins. The patient has to press the correct button for each stimulus once to become familiar with the task. If a stimulus module includes sounds, this option has to be enabled.
If the option "Start level with task 1" is enabled, the patient always starts the session with task 1 of the selected level. This option should be used for patients who had a longer pause since the last session in order to avoid overwhelming them with tasks that are too difficult at the start of the new session.

Feedback:
The possibilities of the feedback have already been described in Performance feedback.

No. of stimuli/task:
This setting determines the sum of the relevant and irrelevant stimuli to be displayed in the course of the task. When working in level type 4, the stimulus number should not be less than 100, to ensure that the median stimulus interval is stabilized.

Stimulus interval (ms):
The parameter is used differently depending on the level type.
In ***level type 1*** (new stimulus after reaction), the stimulus interval is not used. A new stimulus is presented immediately after the reaction to the previous stimulus.
In ***level type 2*** (constant stimulus interval), the stimulus interval determines the time from stimulus start to stimulus start. If there is no reaction after the time set with the stimulus interval, the reaction is evaluated as incorrect and the next stimulus appears.
In ***level type 3*** (stochastic stimulus interval), the stimulus interval describes the time from the patient's reaction to the appearance of the next stimulus (interstimulus interval = stimulus interval 0 to 75%).
In ***level type 4*** (adaptive stimulus interval), the stimulus interval set in the parameter menu is the start value for the stimulus interval. When the patient reacts correctly to stimuli, the stimulus interval is reduced by 3%. When the patient reacts incorrectly to stimuli, the stimulus interval increases by 3%.

Stimulus duration:

The stimulus duration describes the duration a stimulus displays on the screen.

With irrelevant stimuli:
Besides relevant stimuli, irrelevant stimuli are displayed as well. When irrelevant stimuli are shown, the patient may not press any button.

Correlation stimulus reaction:
Various stimulus modules can be selected from the selection menu Correlation stimulus reaction. Stimulus modules can be created, edited, or deleted via the buttons "New stimulus module," "Edit stimulus module," and "Delete stimulus module." Stimulus modules which are marked with a  belong to the default modules and cannot be changed or deleted.

New stimulus module / Edit stimulus module:
In the *Responsiveness* training module, new combinations of stimulus and response can be defined. The therapist has the possibility to create new patient-specific stimulus-response tasks or to edit already existing tasks.

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

Current degree of difficulty	1
Duration of session	30 min
Max. percentage of error	10 %
Max. reaction time	800 ms
Number of stimuli per task	50
Stimulus interval	3000 ms
Stimulus duration	2000 ms
With irrelevant stimuli	Disabled
Performance bar	Enabled
Acoustic feedback	Enabled
Visual feedback	Enabled
Practice	Disabled
With imagination of stimuli	Enabled
Start level with task 1	Disabled

High contrast:
The *Responsiveness* module also supports the "High contrast" setting which can be defined in the patient data. If the parameter "High contrast" is enabled, enlarged stimuli display when stimuli module 1 is used.

1.5 Stimulus module editor

With the stimulus module editor, the therapist can edit existing modules or create new ones. Every module should consist of 20 levels with 5 tasks each. Different combinations of stimuli can be assigned to every task. Different task combinations are chosen randomly by the computer during the training and ensure an extremely varied training for the patient.

Level:
Select the level to be edited from the "Level" list. This list is always filled with 20 entries.

Chosen level:
In the section "Chosen level," the level selected from the Level list is always displayed. The respective level type (1 to 4) can be assigned via the "Type of level" selection box.

Combinations:
Before establishing any combinations, the user has to first choose the task type (1 to 5). Any number of stimulus combinations for the selected task can be added or deleted by the user via the buttons **Add combination** and **Delete combination**. In the table columns "Relevant images," "Non-relevant images," "Relevant sound," and "Non-relevant sound," the number of relevant and irrelevant stimuli of the selected combination is automatically displayed. The respective stimuli of the combination are visible in the table "Images of the combination" or "Sound files of the combination" on the tabs **Images** and **Sounds**.

Combination background:
Another background image and (or) background sound can be added to every combination via the **Combination background** button. The button opens another window for identifying or modifying visual and acoustic background stimuli.

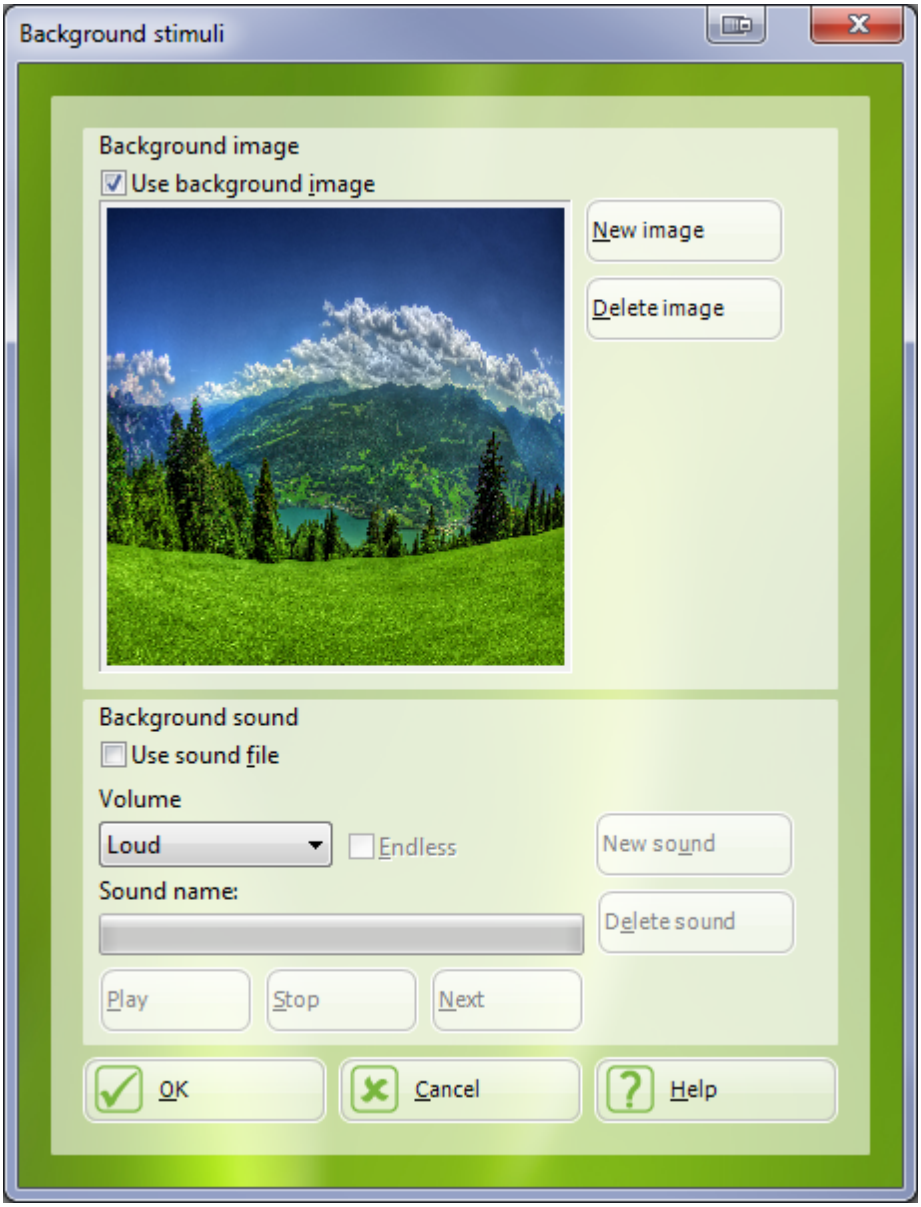

Fig. 4: Background stimuli.

In the new window (see Fig. 4), the background can be modified acoustically and/or visually via the buttons **New image**, **Delete image**, **New sound,** and **Delete sound**. If no background has been selected, all stimuli are presented on the usual green RehaCom background. Therapists can include their own sound and image files for the background as long as the image files use the format .bmp and the sound files use the format .wav. The respective background image or the background sound are only enabled in the training if the option "Use background image" or "Use sound file" is marked.
Additionally, the volume (Loud, Medium, Quiet) can be set for the background sound. The parameter "Loud" refers to the current setting of the Windows system. The parameter "Medium" and "Quiet" corresponds to half or quarter of the volume "Loud," respectively. To play a background sound permanently during training, the

option "Endless" has to be selected.

Images:
On the tab "Images," visual stimuli can be additionally added to or removed from the chosen combination (marked combination from the list "Combinations").

In the list "All images," all images are listed which can be added to a stimulus combination. Besides the actual stimulus, to which the patient has to react during training **(active image)**, this stimulus may contain a second image **(passive image)**. The passive image can be used as advance notice for the active stimulus during training. The passive image is displayed during the entire duration of the task and determines the position where the active image will appear later. In the image table, the columns for the active and passive images are marked with an "A" (active) or a "P" (passive).

Add/Remove image:
To add an image to a stimulus combination, you first have to select the desired image from the table "All images". Subsequently, the requested parameters for the picture need to be chosen from the group "Image properties". The image position can be set or changed in the yellow grid by a simple mouse click. This grid corresponds to the training field where the patient will see the images during training. If the image position Is to be randomly chosen by the computer during training, the user has to mark the option "Stochastic position".
The image size can be selected from the selection box "Image size". 3 different image sizes are available:

big: 160 x 160 Pixel
medium: 80 x 80 Pixel
small: 40 x 40 Pixel

From the selection box "Choose button", a button of the RehaCom keyboard can be assigned to an image. The patient has to push this button later in the training when the image appears. When using a RehaCom keyboard that has only one **OK** button, both the left and the right **OK** button can be selected. For subsequent training, only one **OK** button is related to the chosen stimulus.
The assignment of one button to a certain image is only necessary in case of a relevant stimulus.
The user has to enable the option "Relevant stimulus" if the chosen image will be a relevant stimulus. If the advance notice (passive image) is to be displayed during training for this stimulus, the field "With advance notice" has to be enabled.
Furthermore, only the passive image of a stimulus can be displayed with the option "Only advanced notice". Those pictures are visible for the patient throughout the entire task.
To consider all visual stimuli of the marked combination in one overview, the user has to press the **Preview** button. This preview corresponds to the later display of the images in the training.

By pressing the button "  ", the image selected in the "All images" table is included in the table "Images of the combination" with the set image properties.
In order to display different images with different frequencies, identical images can be added into the table "Images of the combination" as often as required.

If the user wants to remove an image from the table "Images of the combination", then the image should be selected and the "  " button should be clicked.

Add/Delete sound file:
In order to add a sound to a stimulus combination, you first have to select the desired sound from the "All sound files" table. Then, the desired parameters for the sound file needs to be chosen from the group "Sound characteristics".
The volume of the sound file can be selected from the selection box "Volume". Three different volumes are given (Loud, Medium, Quiet). The parameter "Loud" refers to the current volume setting of the Windows system. The parameter "Medium" and "Quiet" corresponds to half or quarter of the volume "Loud", respectively. To play a sound file during the stimulus duration of training permanently, the option "Endless" has to be selected.
From the selection box "Select button", a button corresponding to the RehaCom keyboard can be assigned to a sound. The assignment occurs according to the key allocation for an image.
The user has to enable the option "Relevant stimulus" if the chosen image shall be a relevant stimulus.

By pressing the button "  ", the sound file selected in the "All sounds" table is included in the table "Sound files of the combination" with the set sound properties.
In order to display different sounds with different frequencies, identical sound files can be added into the table "Sound files of the combination" as often as required.
If the user wants to remove a sound from the table "Sound files of the combination", then the sound should be selected and the "  " button should be pressed.

Modify stimulus from combination
To change the training properties for a selected stimulus from the tables "Images of the combination" or "Sound files of the combination", all settings in the group "Image properties" or "Sound properties", respectively, have to be adjusted to the requested parameters. Then, the button  **Modify** has to be pressed.

Caution:
A maximum of eight different relevant stimuli (images or sound files) can be added to one combination.

Add/Edit/Delete new stimuli
To add or delete **new images** or **sound files** to/from the master data, the button **Modify stimuli** on either tab has to be pressed, which opens the **Create stimuli**

dialog box.

The **Create stimuli** dialog box consists of the group "Images" and the group "Sound files". The "Images" group contains a list of all image stimuli which are currently available for the different stimulus modules. There are tabs in which the active image and the passive image can be uploaded.
To add a new image to the table, you have to press the button **New image** on the tab **Active image**. Only image files with the format "*.bmp" may be used.
After an "active image" is added, a passive image can be assigned to this image. The button **Change image** has to be confirmed on the tab **Passive image**. There is no obligation to assign a passive image to the active image.
As image name, the file name of the image is used as standard. If you want to change the name of the image, you have to enter the new image name in the input field "Image name". After entering a new name for the image, press the **Change name** button.
The currently used images of the selected list entry can be exchanged or removed via the buttons **Change image** and **Delete image**.

The “Sound files” group contains a list of all the sound stimuli available for the different stimulus modules. New sounds can be added, exchanged, or deleted via the buttons **New sound**, **Change sound**, and **Delete sound**. Only sound files with the format "*.wav" may be used. The name change of a sound file occurs in the same way like the change of the image name.
Each selected sound can be played, paused, or continued via the buttons **Play**, **Stop**, and **Next**. If the option "Endless" is marked, the sound file is permanently played. The option "Endless" in this menu is only used for testing the sound file.

Caution:
The images or sound files that are marked with a  in the column "Standard" belong to the standard stimuli and therefore cannot be changed or deleted.

1.6 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
Task type	Task type (1-5) of the level
Stimuli	Sum of relevant and irrelevant stimuli
Stimuli rel.	Number of relevant stimuli
Stimuli irrel.	Number of irrelevant stimuli
Correct total	Number of correct reactions in %
Mistakes total	Total number of mistakes (including missing reactions)

Mistakes button	Number of reactions with a wrong button
Mistakes irr. stim.	Number of incorrect reactions to an irrelevant stimulus
Omissions	Number of missing reactions to a relevant stimulus
Reac. interstim.	Number of reactions during interstimulus interval
Reac. time Median	Median for all reaction times in ms
Correct button	Number of correct reactions to relevant stimuli
Correct irrel. stim.	Number of correct non-reactions to irrelevant stimuli
Reac. time Quartil1	Reaction time quartile 1 in ms
Reac. time Quartil3	Reaction time quartile 3 in ms
Train. time task+	Effective duration of the training in h:mm:ss
Breaks	Number of breaks caused by the patient

Tab. 5: results

For the parameters Reac. time Quartil1, Reac. time Median, and Reac. time Quartil3, only reactions with relevant stimuli are used for calculation.

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

Progression/Course:

After pressing the **Progression** button, a graphic shows the course of the reaction time for a single task of a level. In the history chart, different error types and right reactions are displayed in varied colors (see Fig. 5).

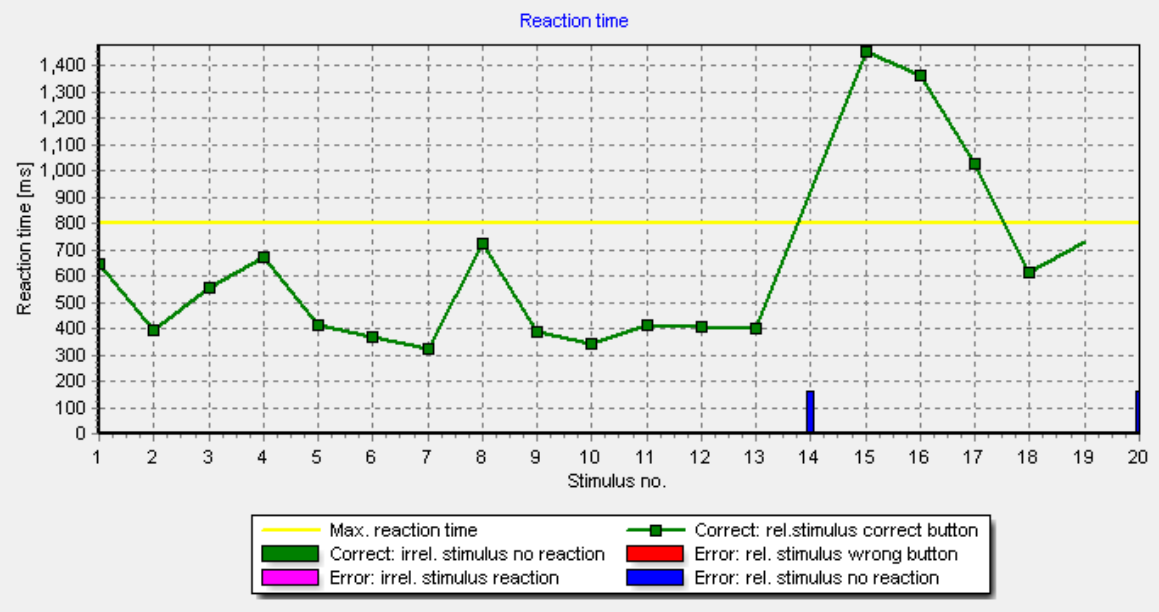

Fig. 5 Reaction time results

2 Theoretical concept

2.1 Foundation

The **Responsiveness** 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, rapidly reaction to a warning stimulus (alertness). **Tonic activation**, however, is an attention level which stays stable for a longer period of time.

Selective attention, which is also relevant in this RehaCom module, is considered the action of focussing on specific aspects of one task while ignoring irrelevant stimuli (Sturm, Hartje, Orgaß, & Willmes, 1994).

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 a stimulus.

These processes are partially 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. 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, and
- Motor action.

Reaction time is the description for the length of time between the presentation of the stimuli 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) distinguishes 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 stimuli,
- Rate of appearance of relevant stimuli,
- The possibility of associative coupling between stimulus and reaction.

The ability to react towards acoustic stimuli by means of a motor action requires two basic skills: an ***intact capacity of hearing*** and an ***intact capacity of reacting***. The correct connection of acoustic stimulus and motor reaction is based on the correct interpretation of the meaning of the stimulus.

Hearing disorders may have *peripheral* or *central* origin.
Cerebral hearing disorders can be distinguished according to *anatomical* (1), *psycho-acoustic* (2), and *neuro-psychological* (3) criteria.
One differentiates between:

1)

- hearing disorders after brain lesion
- diencephal hearing disorders
- telencephalic hearing disorders

2)

- disorders of the *loudness* perception
- disorders of the *timewise* perception
- disorders of the *spectral* perception

- disorders of the *spatial* perception

3)

- disorders of the acoustic *discrimination* capacity
- disorders of the acoustic *recognition* capacity
- disorders of the acoustic *remembrance* capacity
- disorders of the acoustic *attention*
- acoustic stimuli phenomena

Psycho-acoustic deficits can all be summarized under the term *disorders of acoustic discrimination capacity*. Only disorders of speech or sound perception that go beyond phoneme discrimination should be called *acoustic perception disorders* (Scherg, 1988).
In unilateral telencephalic lesions, the impairment concerning simple psycho-acoustic parameters always affects the ear countralateral to the lesion, independent of the hemisphere dominance. These impairments can have different profiles according to each individual lesion (Efron et al., 1985). The capacity to filter out relevant acoustic stimuli is difficult also for healthy persons if there are more than a certain number of sounds or/and if the sounds exceed a certain volume. However, this limit seems to be moved fundamentally in unilateral telencephalic hearing disorders.

The basic symptom of central hearing disorders is the serious difficulty for patients to follow discussions if there are loud background noises or several people talking at once. Often patients also report a changed or asymmetrical perception of sounds (cf. Blaettner & Goldenberg, 1993).
In contrast to patients with peripheral hearing disorders, patients after serious telencephalic lesions often can distinguish quiet sounds better than loud sounds, and consequently understand speech better if speaking quietly (cf. Blaettner & Goldenberg, 1993).

Depending on the locality of the damage in the left or right hemisphere, serious cerebral hearing disorders can differ for verbal or non-verbal material (cf. Scherg, 1988). Left temporal brain injuries are often accompanied by aphasia, and—in case of sensory aphasia—speech cannot be understood in spite of intact sound and tone differentiation. In contrast, right hemisphere brain injuries seem to cause worse performances in complex acoustic discrimination tasks (cf. Blaettner & Goldenberg, 1993). Reduced discrimination capacities also appear in left hemisphere injuries and lesions of the brain stem; in the latter, the interruption of afferent connections in the brain stem presumably leads to a drastic reduction of the information the sound stimulus contains, and consequently a clear stimulus discrimination on the intact cortical level is no longer possible.

Attention deficit disorders often affect more than the acoustic modality. A special case of this disturbance is neglect, which is the non-observance of stimuli on the side contralateral to the lesion. If the neglect phenomena appear only in the acoustic

modality, they are the expression of a telencephalic hearing disorder. Mostly however they are accompanied by visual and tactile disturbances indicating a superordinate functional disturbance (Heilman & Valenstein, 1972).

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 toreaction 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) sees 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 aim of the training **responsiveness** 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.

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 and acoustic modality. Through the training of the patient's responsiveness, the recognition of sounds can be supported and trained simultaneously.

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 **Responsiveness** is also used for patients with deficits in selective attention without a general slowness of reaction.

Training with the Responsiveness 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.

On the basis of results of diagnosis, it should be decided if the **Responsiveness** module is used alone for therapy or in combination with additional modules, such as **Reaction Behavior** (REVE). The modules **Divided Attention** (GEAU), **Divided Attention 2** (GEA2), **Attention and Concentration** (AUFM) and **Vigilance** (VIGI) contain additional training for different specific attention deficits.

2.3 Target groups

The use of the module **Responsiveness** is recommended for patients with deficits of reaction speed and reaction precision after cerebral lesions, but also in disorders of the selective attention performance, disorders of the acoustic discrimination, recognition and/ or memory capacity. Impairments to reaction capacity can appear to some degree in all neurological diseases. This applies to attention deficits as well.

In telencephalic lesions, the patient often does not have access to his/her auditory perception anymore, so training a patient's ability to distinguish sounds using clear, basic criteria (cf. Scherg, 1988) may be helpful. During training, the acoustic stimuli should be presented in a volume pleasant to the patient; speaking loudly, for example, often may lead to overstimulation.

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.

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 Responsiveness, 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 can be used with children 11 years and older. The module uses child-friendly instructions for patients up to the age of 14.

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