HASOMED

RehaCom®

Cognitive therapy

Logical Reasoning

HASOMED
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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).

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 module **Logical Reasoning** uses problem solving exercises where the patient must complete a series of images. The analysis of the problem situation and of its elements is primary. By increasing the difficulty of the logical series and overlapping several logic structures, the patient should learn to recognize the concepts underlying each task and use these concepts to solve the problem.
The module consists of three different types of tasks, each requiring a separate approach. Starting in level 1, only the types *Logical Series* and *Matrix* are trained. *Numeral tasks*, if activated as parameter, and tasks of type *Categories* start to appear at level 4, while *Categories* tasks end at level 17. The task type to be solved always changes after two tasks of one type.

For each task type there is a help, which can be called up at any time via the help button (+). From there you can display the strategy which should be used to solve the task type by pressing the help button again. If this is not enough, you can press the help button for detailed explanation of the task in which you can actively practice.

The operation is slightly different depending on the input mode set. If the training is operated with the mouse, the selection cards can be moved by pressing and holding the left mouse button. If you now move the mouse pointer over an empty card slot, it will discolour slightly. Releasing the mouse button places the card on the area. Alternatively, a double-clicked card is placed on the result field. If there is already a card, both exchange their position. The touchscreen input mode works equivalently. If the *keyboard mode* is set as an input mode, a selection frame, which can be moved using the arrow keys on the console or keyboard, is used for navigation. By pressing the OK button, cards can be picked up or placed again. After all target areas are occupied, the selection frame will activate the Continue button. By pressing the OK button the task can be completed. If corrections are necessary the selection frame can be moved back to the cards by pressing the arrow key that points in their direction.
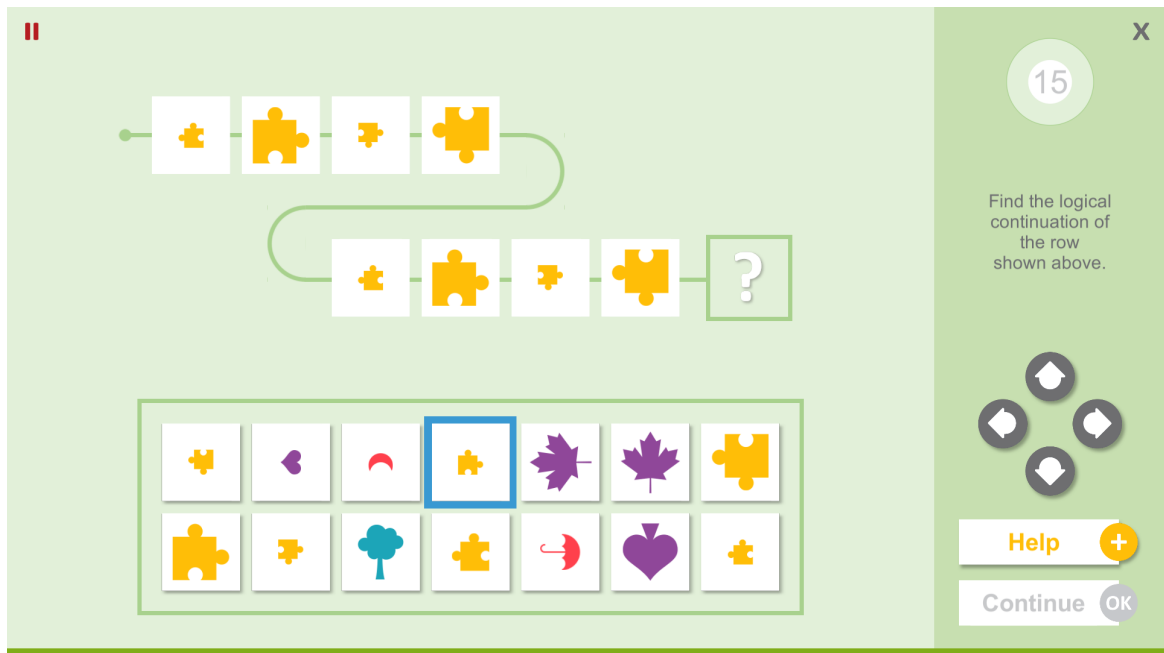
Fig. 1: Training with keyboard input

Task type "Logical Series"

In the training, a series of pictures with simple graphic figures or illustrated pictures is shown. The patient must find the relationship between the individual pictures in the series and, through induction, derive a rule (figure reasoning) that clarifies what the next picture in the series is (von Cramon & Matthes-von Cramon, 1993). When the patient has established what the rule is, he or she must then select the relevant picture from a matrix of pictures. There are several properties that can change: shape, color, size, rotation and quantity. Whereas in simple levels usually only one property changes, several properties can alternate at the same time with increasing difficulty, even in different rhythms.

The picture series appears in the upper part of the screen (see Fig. 1). They consist of a minimum of 6 pictures and a maximum of 11. If the number of pictures is greater than 6, the logical series is distributed over two rows which are spaced out above each other. A curved line illustrates the unity of both lines. At the end of the row is a box with a question mark. On this the desired picture must be placed.

Fig. 2: Task of type Logical Series

If the parameter *Numeral tasks* is activated, the number series, where you have to recognize certain calculation rules in order to find the solution you are looking for, will be used for 40% of all Logical Series tasks. The basic arithmetic operations summation, subtraction and multiplication are applied. In more difficult levels, those operations will be combined.

Fig. 3: Numeral Task

Task type "Matrix"

The task type *Matrix* works similar to the *Logical Series* type. However, the images are arranged within a 3 × 3 matrix. In order to reach the solution, all rows and columns of the matrix must be considered. The result field is randomly placed on one of the edge fields of the matrix.
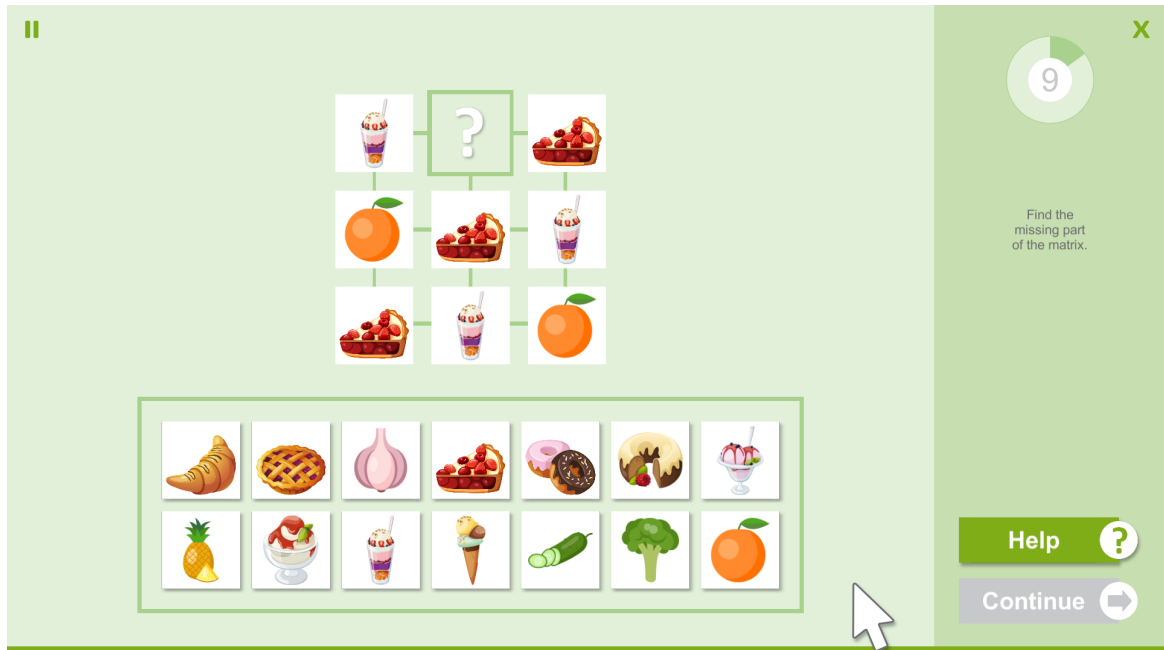

Fig. 4: Task of type Matrix

Task type "Category"

The implementation of this type of task is very different from the other types of tasks. Here, all images that are available for selection must be arranged in thematically related categories. Two or three categories, each with three or four elements, may be required. The degree of abstraction of the groupings increases as the levels progress, making the assignment of the objects increasingly difficult.
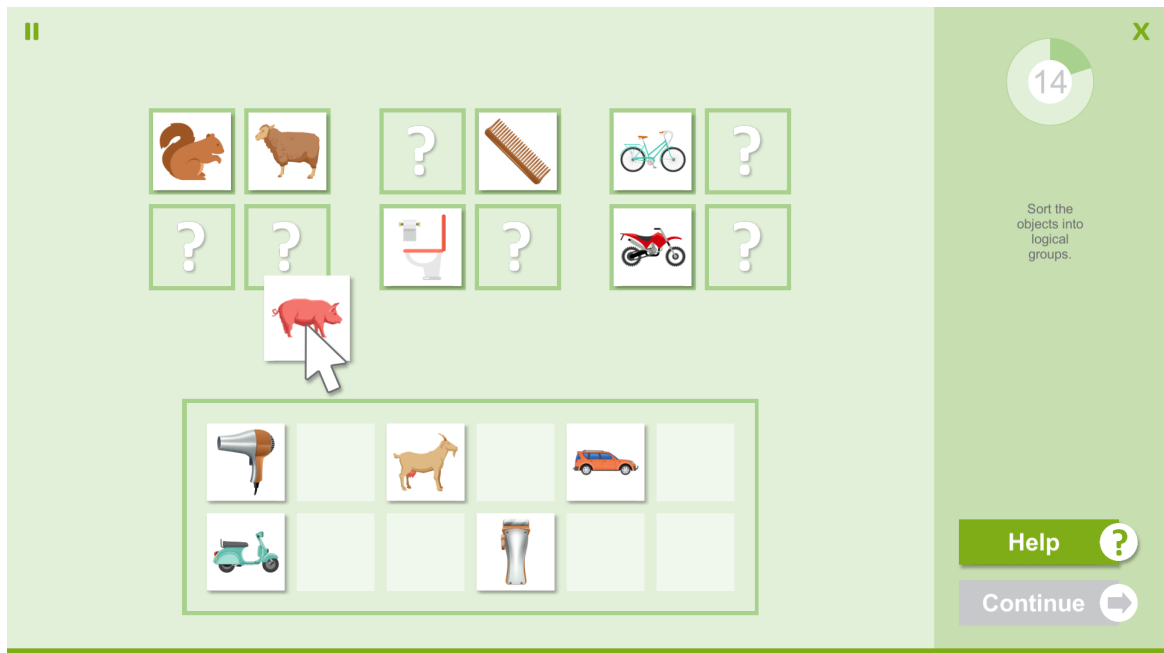
Fig. 5: Task of type Category

1.2 Performance feedback

The performance feedback in the Logical Reasoning module is implemented through various visual elements and colors. In addition to visual feedback the auditory feedback can be switched on. When entering a solution, a RehaCom typical sound is played, depending on whether the solution was right or wrong. If a problem of a task type is solved incorrectly during the training for the first time, the feedback shown for this type is explained. The patient's progress is indicated by a circular progress bar. The fill level indicates how many tasks of a level have already been completed and how many will follow. The number in the middle represents the current level.

Task types "Logical Series" & "Matrix"

If the selected solution was correct, a green frame appears around the result field. If the solution is wrong, a red frame appears around the result field. In addition, the desired solution is marked with a yellow frame. In the border area, attention is drawn to the properties that had to be considered for solving the problem.
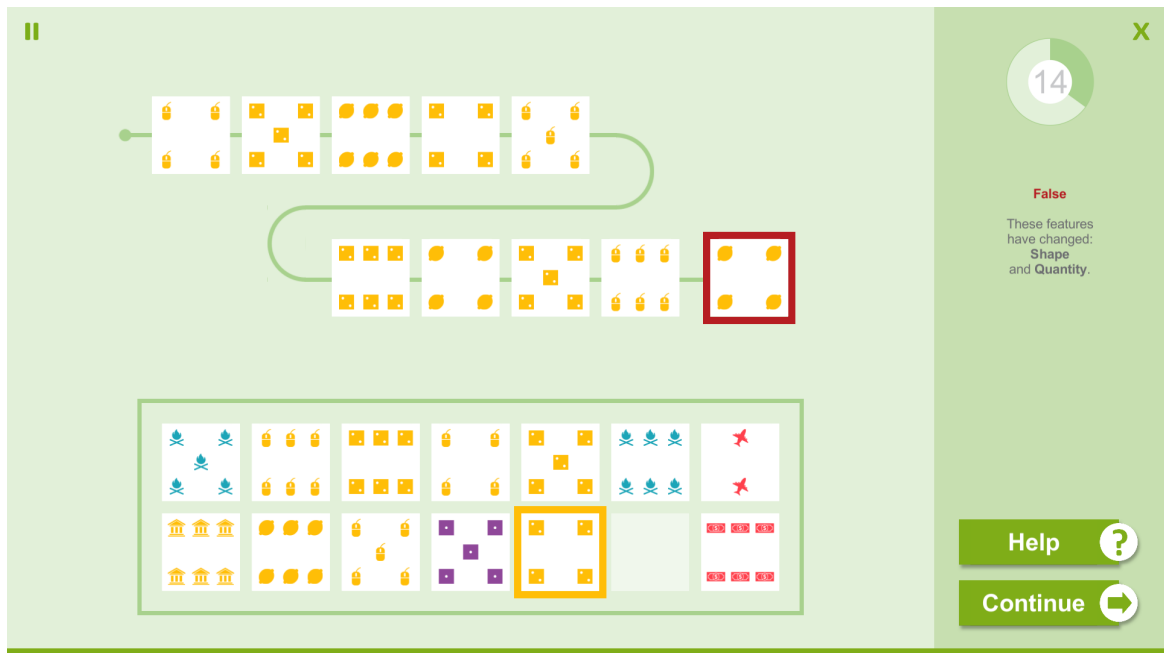
Fig. 6: Feedback of task type Logical Series

Task type "Category"

A green frame is displayed around each correctly formed group. Incorrect groups are marked with a red frame. In addition, the images that do not belong to the group are marked with a red X. Above the groups, their indications are displayed.
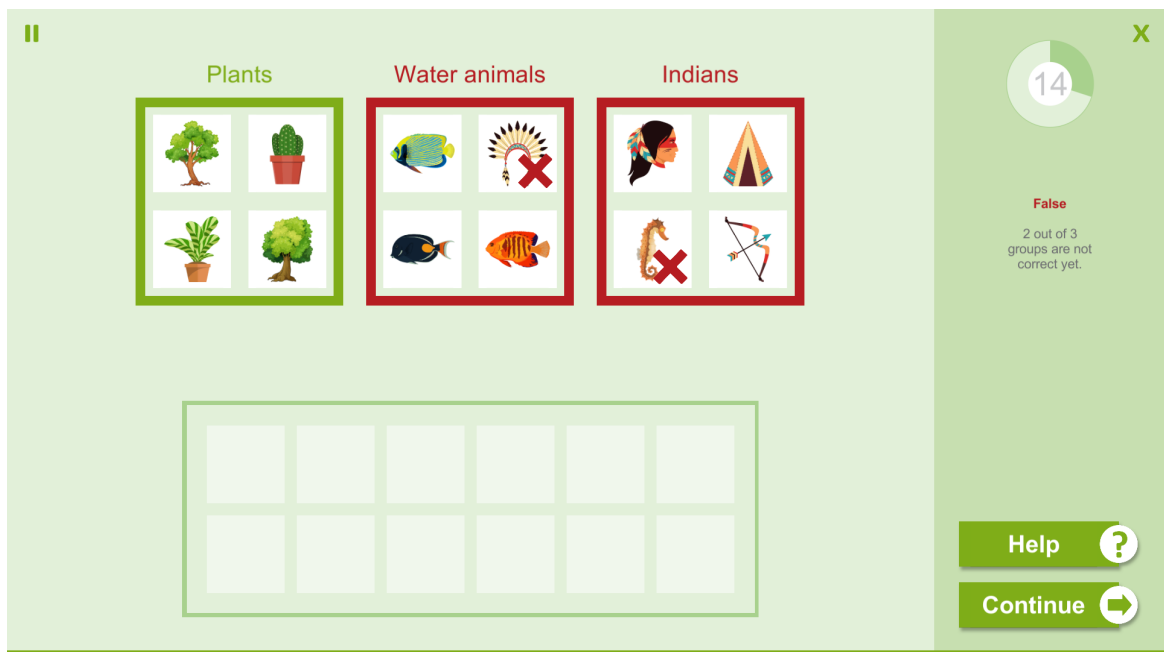

Fig. 7: Feedback of task type Category

1.3   Levels of difficulty

An adaptive setting of the different levels of difficulty is guaranteed.

For the task generation a big picture pool consisting of illustrated pictures and simple figures is used. The following properties are defined, which can change:
- Color: red, blue, yellow, purple
- Size: small, medium, large
- Rotation: 0°, 90°, 180°, 270°
- Number: 1 – 9

The level of difficulty is modified by altering the length and complexity of the series (see Tab. 1 - 3). In the task type Category, the difficulty is determined by the degree of abstraction of the categories to be formed.
At regular intervals, mix levels are interspersed, in which tasks from already trained levels are mixed.
As in the case of all RehaCom modules, the performance requirements at lower levels of difficulty are purposefully low. This provides an easier start for patients with a lower performance ability.
A more efficient patient will complete these lower levels of difficulty more quickly and reach performance ranges better suited to his or her level.
It is not recommended to begin immediately with a higher level of difficulty.

Level	Task type logical series	Task type matrix	Task type categories	Task type numeral tasks
1	Variation of the shape in one of the rhythms AB or AA.	Simple change of shape		
2	Variation of the color in one of the rhythms AB, AA or AABB.	Simple change of color		
3	Variation of the size in one of the rhythms AB, AA, AAB or AABB.	Simple change of size		
4	Mix of level 1 - 3	Mix of level 1 - 3	Two simple categories with four representatives each (pictorial)	Simple summation tasks with different starting points (1 - 20); Rule +1, +2 or +3
5	Rotation by 90°, clockwise or counterclockwise.	Simple change of rotation	Two simple categories with four representatives	Simple subtraction tasks with different starting points (1 - 50); Rule +1, +2, +3

			each (abstract)	or +4
6	Quantity of elements increases or decreases.	Simple change of quantity	Mix of level 4 - 5	Mix of level 4 - 5
7	Mix of level 5 - 6	Mix of level 5 - 6	Three simple categories with four representatives each (pictorial)	Simple subtraction tasks with different starting points (20 - 40); Rule -1, -2 or -3
8	Mix of level 1 - 6	Mix of level 1 - 6	Three simple categories with four representatives each (abstract)	Simple subtraction tasks with different starting points (30 - 60); Rule -1, -2, -3 or -4
9	Mix of level 1 - 6	Mix of level 1 - 6	Mix of level 4 - 8	Mix of level 7 - 8
10	Variation of shape, color or size in one of the rhythms ABC, AABB, AAB, ABCB oder ABCCBA.	Moderate change of either shape, color or size in four possible rhythms	Two moderate categories with three representatives each pictorial)	Mix of level 4 - 8
11	Rotation in one of the rhythms (0°, 90°), (90°, 180°, 0°), (0°, 180°) or (0°, 90°, 180°, 90°).	Moderate change of either shape, color or size in five possible rhythms	Two moderate categories with three representatives each (abstract)	Multiplication tasks with factor 2 or 3 and different starting points (1 - 4)
12	Quantity of elements increases or decreases.	Moderate change of rotation	Three moderate categories with four representatives each (pictorial)	Multiplication tasks with factor 2 or 3 and different starting points (1 - 8)
13	Mix of level 10 - 12	Moderate change of quantity	Three moderate categories with four representatives each (abstract)	Mix of level 11 - 12
14	Variation of shape, color or size in one of the rhythms ABCCBA, ABBC, AACB, ABAC oder AABBCC.	Mix of level 10 - 13	Mix of level 10 - 13	Mix of level 4 - 12
15	Rotation by 90°,	Moderate change of	Three difficult	Summation tasks

	clockwise or counterclockwise, combined with variation of either color or size.	rotation combined with variation of either shape, color or size	categories with four representatives each (pictorial)	with base summands 1, 2 or 3. After each operation, the summand increases by its base value, e.g. +3, +6, +9 etc.
16	Incrementation or decrementation of quantity combined with variation of either shape or color.	Moderate change of quantity combined with variation of either shape or color	Three difficult categories with four representatives each (abstract)	Subtraction tasks with base subtrahends 1, 2 or 3. After each operation, the subtrahend increases by its base value, e.g. -3, -6, -9 etc.
17	Mix of level 15 - 16	Mix of level 15 - 16	Mix of level 15 - 16	Mix of level 15 - 16
18	Two independent rotation sequences rotating by 90°, clockwise or counterclockwise, combined with variation of shape in AB rhythm.	Change of rotation combined with variation of quantity		Alternating execution of summation and subtraction with possible operands 1, 2 or 3.
19	Two independent quantity incrementing or decrementing sequences combined with variation of shape in AB rhythm.	Change of shape combined with variation of either color, size or rotation		Alternating execution of summation and multiplication with possible operands 2 or 3.
20	Mix of level 18 - 19	Mix of level 15 - 19		Alternating execution of subtraction and multiplication with possible operands 2 or 3.
21	Rotation by 90° or 180° combined with variation of the color in one of the rhythms AB or ABC.	Change of shape combined with variation of two of the three attributes color, size and rotation		Mix of level 18 - 20

22	Variation of shape, color and quantity at once.	Change of shape combined with variation of two of the three attributes color, size and rotation		Two independent summation sequences.
23	Variation of shape, color and size at once.	Mix of level 18 - 22		Two independent sequences where one executes summation, the other subtraction.
24	Mix of level 21 - 23	Mix of level 18 - 22		Mix of level 18 - 23
25	Mix of level 15 - 23	Mix of level 15 - 22		Mix of level 15 - 23

Tab. 1: Difficulty structure

1.4 Training parameters

Specific settings for the training module can be adjusted (see Fig. 8). 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.
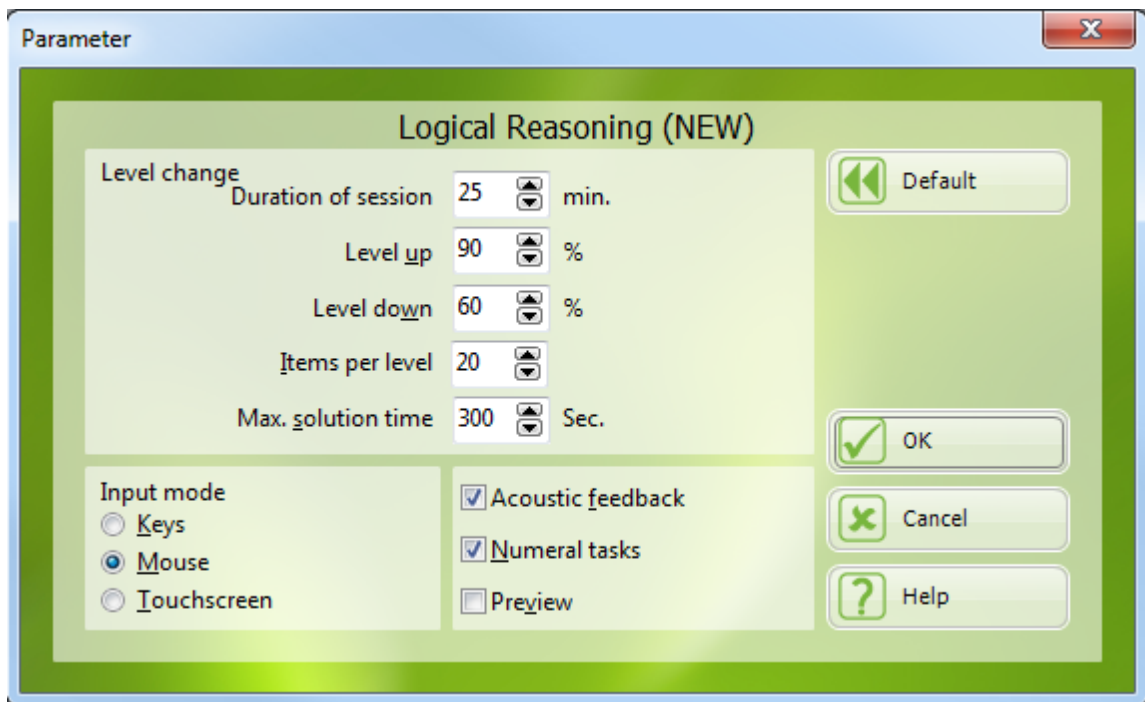

Fig. 8: Parameter window

Duration of session:

A training time of 25–35 minutes is recommended.

Level up:
After the patient has worked through all the tasks for a level, a percentage is computed for the number of the correct decisions in relation to the total number of tasks.
Regardless the type of error, each incorrect response is only registered as a single error. If this percentage value is higher than the one set for **level up,** the module increases the level of difficulty for the next task.
At the beginning, it is recommended that the threshold for increasing the level of difficulty be reduced for patients with a lower performance level. This way, the patient can reach a higher level more easily and his or her motivation for training increases. However, once the patient's performance stabilizes, the parameter should be increased again.

Level down:
If the percentage correct is lower than the one set for **level down**, the module decreases the level of difficulty for the next task. At the beginning, it is recommended that the threshold for increasing the level of difficulty be reduced for patients with a lower performance level. The module then allows a greater number of mistakes before the level of difficulty decreases.

Items per Level:
This parameter determines how many series a patient must solve at each level of difficulty.

Maximum solution time:
For the set time, the patient can think about the options and make a decision about the next picture in the series. After this, the patient is presented with the next task. If a task remains unresolved when time runs out, this task is evaluated as incorrect (Time error). By default, this parameter is set to 5 minutes (300 seconds). This time is sufficient in order to solve the task without time pressure. With high performing patients, a stress factor can be introduced by shortening the solution time (e.g., 30 seconds). High performing patients can benefit from the higher requirements and thus their motivation is increased.

Input mode (Operation mode):
The possible input modes are *Keys*, *Mouse* and *Touchscreen*.

Acoustic feedback:
The parameter for acoustic feedback can be enabled so that a typical tone is sounded if the patient chooses an incorrect picture to complete the series. The error tone can cause disturbances if several patients are training in one room. The acoustic feedback should then be disabled or headphones used.

Numeral tasks:
If numeral tasks are activated, additional tasks are presented in the task type

"Logical Series", in which certain calculation rules must be recognized.

Preview:
If the preview mode is enabled, the currently selected picture will appear at the end of the series. For particular patients, this will greatly simplify the tasks.

The following default values are automatically set for a new training:

Level of difficulty	1
Duration of session	25 minutes
Level up	90 %
Level down	60 %
Items per level	20
Max. solution time	300s (5 minutes)
Input mode	Mouse
Acoustic Feedback	Enabled
Numeral tasks	Enabled
Preview	Disabled

Tab. 5: Default 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
Picture series	Number of picture series per level of difficulty
Correct	Number of correctly solved picture series
Correct %	Correctly solved picture series in %
Mistakes total	Number of incorrectly solved picture series
Mistakes time	Number of errors due to exceeding the given time
Median reac. time	Median of all reaction times in s
Mistakes shape	Number of shape errors
Mistakes color	Number of colour errors
Mistakes size	Number of size errors
Mistakes rotation	Number of rotation errors
Mistakes quantity	Number of quantity errors
Mistakes numerals	Number of numeral errors
Mistakes categories	Number of category errors
Quartil 1 reac. time	Reaction time quartile 1 in s

Quartil 3 reac. time	Reaction time quartile 3 in s
Train. time task	Effective training time in h:mm:ss
Breaks	Number of interruptions by the patient

Tab. 6: Results

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.

Specific information about the current session or about all sessions can be printed out.

2 Theoritical concept

2.1 Foundations

Logical reasoning and problem solving are some of the most complex human abilities. They are classified as the executive functions, which are used whenever a person is confronted with new, complex situations and questions for which no previous approach is available (Matthes-von Cramon, 1999).
Logical thinking refers to a process by which people develop and evaluate logical arguments (Anderson, 1988). Sohlberg and Mateer (1989) have distinguished three categories of higher thought processes.
Also, concept formation is the ability to analyze relationships between objects and their qualities. Schaefer (1985; von Cramon & Matthes-von Cramon, 1993) defines problem solving thinking as precise logical and analytical thinking in which a given initial state is to be changed into another, desired state (end or expected state). The discrepancy between initial and target state can be reduced by different approaches, depending on the problem (Anderson, 1988).

Problem solving processes represent integrated cognitive functions, which require basic abilities like attention, memory, an intact visual perception and language processing (Sohlberg & Mateer, 1989).
The success of an action is strongly dependent on cognitive processes that control behavior. The preconditions for successful self-control are consciously paying attention as well as the continuously retaining and actively using information. One must continually focus on the primary purpose of an action and any related secondary goals in order to execute the individual steps toward that purpose. The ability to take learned information and to precisely utilize it to control behavior is designated as *working memory.* A functional working memory is a crucial prerequisite for problem solving thinking.

In the models of information processing of Rowe (1985) and Sternberg (1985) (cf. von Cramon & Matthes-von Cramon, 1993) the following components of problem solving processes are stated:

- problem identification and analysis,
- generation of (alternative) hypotheses,
- selection of suitable solution strategies,
- modification of strategies according to internal or external feedback, and
- evaluation of the effectiveness of the chosen solution module.

These components are referred to as meta-cognitive processes, which become control functions within the information processing activity.

Sternberg (1985, cf.von Cramon & Matthes-von Cramon, 1993) distinguishes these as meta-components from lower order components which are required for carrying out of different strategies during problem solving. Such performance components

are

- the encoding of stimuli,
- the matching and combination of information, and
- the analogy of the application of previous knowledge to new situations.

Problem solving, logical reasoning, and planning abilities are functions controlled by the frontal brain. A conclusive pure model introduction of mechanisms which are involved in these integrated functions for neural-anatomical correlates and the mode of operation does not exist up to now (Sohlberg & Mateer, 1989).

Among other things, frontal structures are instrumental in the following functions:

- Selection of primary purpose,
- Selection of information,
- Planning and initiating actions,
- Control and self-regulation of own actions,
- Learning from responses,
- Anticipation from active consequences, and
- Ending intended actions.

Among the cognitive components related to problem solving and reasoning, inductive reasoning is of the greatest practical importance. Inductive reasoning refers to the ability to derive general rules, models, concepts, or regularities from particular experiences and apply them to new events (Waldmann & Weinert, 1990). Typical tasks for these processes of hypothesis formation and hypothesis examination are:

- Analogies,
- Completion of a series,
- Matrix tasks,
- Classification and concept tasks,
- Word location tasks,
- Metaphors and proverbs, and
- Estimation procedures.

Problem solving is considered creative if the solutions are original, expedient, useful, accurate, and valuable for a given task and the process for solving the problem shows that the patient adapts to circumstances rather than follows a rigid pattern. This is in contrast to *convergent thinking*, where solving problems does not require creative thinking to derive a solution.

A special case in problem solving thinking is **planning** of actions. The term *planning* means to explore and coordinate in advance all variables affecting the objective. Mental planning sequences are planned actions with flexible and

reversible components. The individual actions are studied regarding their consequences and put together as a series of actions which are once more tested for possible consequences (von Cramon & Matthes-von Cramon, 1993).

Problems in the patient's ability to plan actions, skills in problem solving, or lack of understanding about the illness can reduce the effectiveness of therapeutic memory strategies because the use of therapeutic strategies outside the clinical setting is often inconsistent.

2.2 Training aim

The aim of the training is to improve the patient's ability to think logically and to solve problems. The module **Logical Reasoning** trains the patient using a specific form of logical reasoning - the completion of a series - which is trained by means of induction.

Which therapeutic procedures are appropriate should be based on a comprehensive neuropsychological assessment. The assessment must include measures of visual perception/exploration, visual-spatial functions, and language processing because deficits of these basic functions can affect a patient's logical reasoning ability.

Treatment of such functional deficits should take priority (Sohlberg & Mateer, 1989). Motivation and behavior problems, however, which are associated with deficits in executive function must be given special consideration.

To improve a patient's problem solving abilities, especially the development of strategies, the patient should be encouraged to develop and establish appropriate strategies. During therapeutic support of the meta-cognative process, the following techniques should be supported:

- Identify and consider solution-relevant information
- Develop precise hypotheses and approaches to the solution
- Plan and analyze the approach to the solution in parts.
- Recognize mistakes and steps that are not effective
- Correct errors and develop alternative approaches to the solution

When the patient's approach to solving a complex task is flawed, it can be helpful to get the patient to discuss the approach that was used to try to solve the problem, and then determine what kind of support that patient needs. This meta-cognitive approach enables the patient to reconsider the relevant information and how it should be organized.

The module enables therapists to explore solutions with the patient to improve complex problem solving.

Before beginning training with Logical Reasoning, patients with attention or visual perception deficits must first be trained with the RehaCom modules **Attention & Concentration** (AUFM) and **Figural Memory** (BILD).

2.3 Target groups

The training module **Logical Reasoning** has been developed for all patients who suffer from impairments to executive functions, particularly in the area of problem solving.

Patients who suffer from various types of brain damage often have disturbances in logical thinking and in required basic functions.

In particular, after uni- or bilateral frontal injuries, the brain suffers *cognitive, emotional*, and *behavioral* disturbances, which based on their functions is known as *Dysexecutive Syndrome* (Baddeley & Wilson, 1988; Stuss & Benson, 1984; Duncan, 1986; Shallice & Burgess, 1991; von Cramon & Matthes-von Cramon, 1992; Stuss, 1992).
These may include:

- attention disorders (selection, focusing),
- vigilance disorders,
- increased distraction/interference vulnerability,
- memory disturbances,
- decreased learning ability,
- disorders in aim-oriented action,
- disturbances to the logical problem solving ability,
- decreased abstraction,
- inability to distinguish important from unimportant (information selection),
- decreased ability to initiate actions and organize them in sequences,
- tendency to perseverate
- incorrect notion of temporal sequences,
- impulsiveness or loss of initiative,
- difficulty understanding and using feedback,
- inability to locate and correct errors,
- dissociation between knowledge and action,
- incorrect anticipation of consequences of action (foresighted thinking),
- incorrect self-regulation and self-perception,
- inadequate social behavior, and
- lack of insight into the illness, anosognosia.

Such disturbances can occur after numerous different types of injuries to the brain

(e.g., primary and secondary degenerative diseases of the brain, hypoxia, infections,), in vascular cerebral injuries (e.g., infarcts, hemorrhages), traumatic brain injuries and tumors with lesions on one or both sides.

Patients often have problems organizing their everyday life because of deficits in their abilities or as a result of dysexecutive syndrome. Because the syndrome itself is a combination of impairments to attention, memory, behavior, and motor skills, it constitutes a particular challenge to therapists in the field of neuropsychology. This is complicated by the fact that patients' basic cognitive functions (*attention, visual spatial performance, memory, speech, and motor skills*) are often more or less impaired and these deficits lead to more complex types of impairments.

Patients who suffer from a deficit in executive functions after damage to the frontal lobe will often exhibit difficulty in analyzing the conditions of a problem and in recognizing important relationships. For these patients, the precise sequence of operations seems broken up and haphazard. They ignore the stage of preliminary investigation of a problem and replace it with purely intellectual operations through unrelated, impulsive actions. Patients with brain damage often have difficulties in forming superordinate categories. They are not able to think abstractly, that is, free from a concrete stimulus and often find themselves being overtly pensive when it comes to a task.

In addition to its use in the area of neuropsychological rehabilitation for cognitive therapies in education, the **Logical Reasoning** training module can also be used in the field of *geriatrics*.

The application of the module is dependent on the kind and scale of the deficits and on the level of intelligence. **Logical Reasoning** can be used with children 12 years and older and the patient should be supported by a therapist when the module is used for clinical purposes.

For this module to be used effectively, the patient must have an intact visual working memory and have the attention capacity to be able to handle the module's demanding tasks. Patients who suffer from a serious form of amnesia and with serious deficits of short-term and working memory should receive a different type of therapeutic treatment or should use less complex modules.

Puhr (1997) examined the effectiveness of cognitive training of several functions with a RehaCom training battery on a random sample of stroke patients. Depending on the disorders of the patients in the sample, particular training modules were selected. The current status of the ability of logical reasoning was determined with the Coloured Progressive Matrices. A transfer effect of first and third order (training effect and effect on the field activities of daily living) could be proved by training. Cognitive deficits were decreased.

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- E -

- F -

- H -

- I -

- L -

- M -