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RehaCom®

Cognitive therapy and brain performance training

Vigilance

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Hard- und Software für die Medizin

RehaCom®

Cognitive therapy and brain performance training

by HASOMED GmbH

This manual contains information about using the RehaCom therapy system.

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

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

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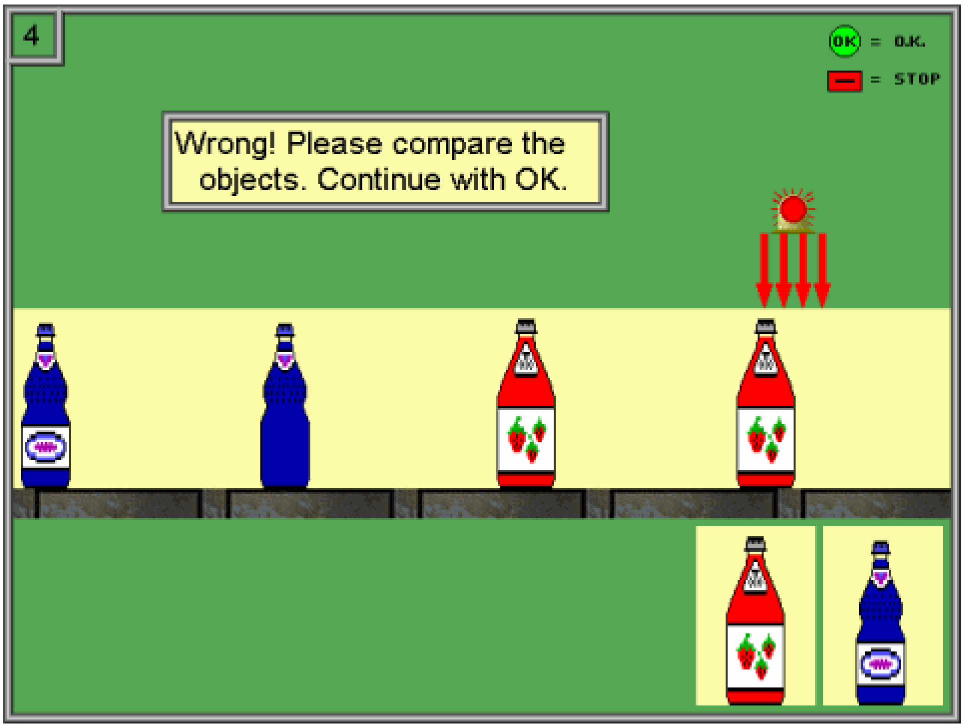
1 Training description

1.1 Training task

In order to achieve a high ecological validity, in the RehaCom procedure Vigilance, the patient works as a high-quality controller at the end of a manufacturing line in a factory (drink and/or canned food production, furniture industry, electronics manufacturing or production of budget subjects).

His task is to test objects which glide by as if on an assembly line (bottles, piece of furniture, electronics item and so forth) and to remove from the assembly line the objects which do not match the constantly visible high-quality standard.

Picture 1 is an example of a training level. The assembly line on is in the horizontal. Here the objects glide continuously and in a smooth fashion from left to right.



Picture 1. An example of the training at a difficulty level of 4, in the moment of a notification of error.
The patient pressed the OK-button for no reason. The false (blue) bottle comes later.

Every consultation consists of a number of tasks. Every task is divided into two stages:

- the **preparation** -
- and the **working phase**.

In the **preparation phase** the patient's are shown the quality standard. The patient is advised to remember, in good detail, all the aspects of the object or objects. The patient can end the preparatory phase by pressing the OK key. The **working phase** then follows.

At the end of the assembly line, on the right-hand side, there are 4 arrows which mark the field in which an incorrect object must be removed by pressing onto the OK-Taste. The patient must spot that there is something wrong with the object and then press OK-key in the exact moment when it is under the arrows. The object then disappears from the assembly line.

The objects which symbolize the high-quality standard are constantly visible under the assembly line. If objects differ from the standard object and/or the standard objects on the assembly line, they should be removed.

Above the arrows of the error field, (where incorrect objects have to be removed), there is a lamp which provides a type of visual feedback : it lights up green during a correct decision and red when an incorrect decision is made.
Once again there is particular advice as to which keys should be used for the procedure Vigilance. The OK-key for selection of erroneous objects and the red "-" key (training interruption by the patient) are only keys which should be used.

On the above left is a number which display the **current level of difficulty**.

The decisions of the patient are evaluated and distinguished by the procedure into the following types of errors:

- an incorrect object was overlooked,
- a correct object was incorrectly selected by the pressing of the OK key.

The mistakes as well as the type of error are registered and form the basis for an adaptive training method of the procedure **Vigilance.**

The procedure can also be used without the Reha-Com panel.

1.2 Performance feedback

A visual and/or an audible feedback are available during the work "on the assembly line". The visual feedback was already described. In the case of an activation of the acoustic feedback different sounds occur during correct and wrong reactions.

The stop in the case of error is recommended especially for weaker patients. The assembly line then stops during wrong decisions. The patient has the possibility to determine the error which ocurred by observing the arrangement of the objects on the assembly line with high-quality standard. The assembly line is turned on with pressing the OK-Taste again and work goes on.

1.3 Levels of difficulty

The procedure works in an adaptive way. It uses 5 graphics pools of solid objects (furniture, bottles, glasses, small and big household objects) and 3 pools with abstract objects (symbols, geometric figures). Each object has 3 variations (easy, middle, difficult), which are used to specify the differences in the incorrect objects from the original objects.

The difficulty of the task increases when, on the one hand, the number of the objects (number of the high-quality standards) to be matched increases and on the other hand, when the differences from the standard object become smaller and smaller.

In determining the level of difficulty, one must distinguish between the processing of abstract objects and concrete subjects. For both classes, 15 difficulties which are documented in the following table exist:

Table 1
Structure of the level of difficulty.

level of difficulty	image details	no. of standard objects
1	low	1
2	middle	1
3	high	1
4	low	2
5	middle	2
6	high	2
7	low	3
8	middle	3
9	high	3
10	low	4
11	middle	4
12	high	4
13	low	5
14	middle	5
15	high	5

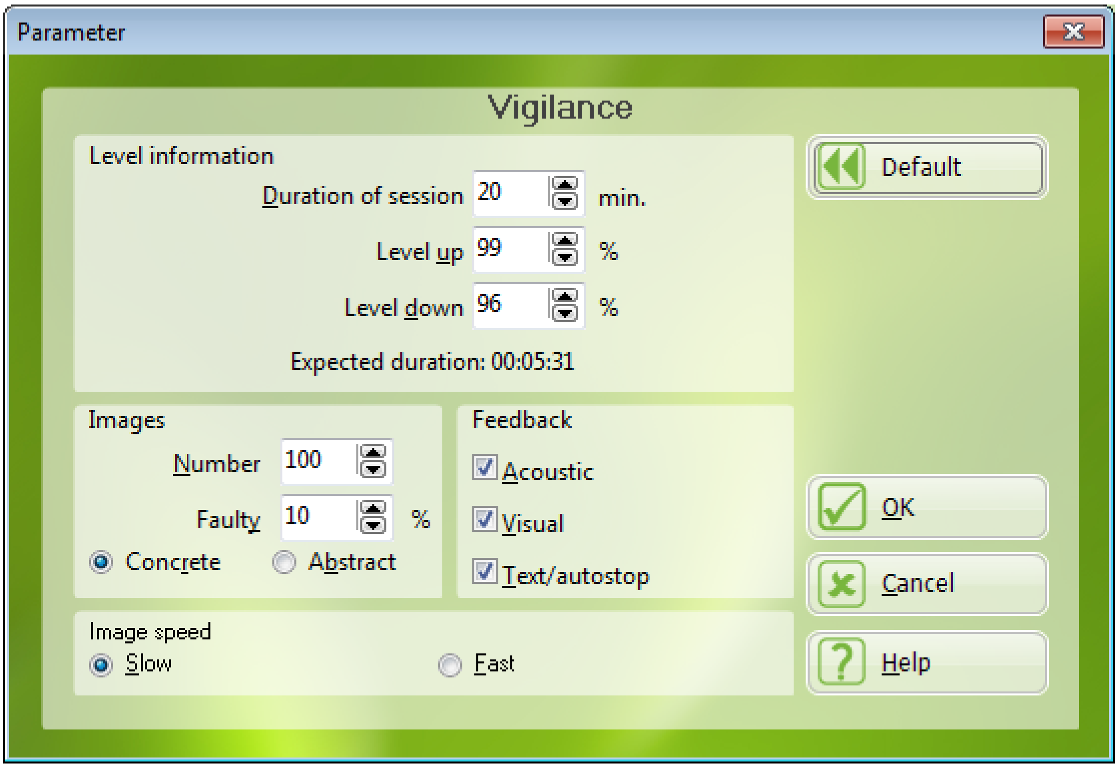
After the completion of a task (processing a determined number of objects), the procedure computes the part of the correct decisions in relation to the number of objects as percentage. If this percentage exceeds the threshold defined as **'continue to the next level'**, the patient then tries the next level of difficulty. If the percentage falls below the value defined as **'repeat the previous level'**, then the patient must repeat the previous level to the one he was working on. If the percentage falls between **'continue to the next level'** and **'repeat the previous level'** then the patient repeats a level with the same difficulty as the one which he was working on.

In addition, it is important to refer to the differences of training with concrete subjects and abstract objects. Training with abstract objects is in general simpler compared to work with concrete subjects. The alternation of training between concrete and abstract one material should be considered when interpreting the training results.

1.4 Training parameters

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

Picture 2 shows the Parameter Menu.



Picture 2. Parameter-Menu.

Current level of difficulty:
The level of difficulty, which ranges from 1 to 15 can be set up in the Therapy Menu.

Duration of the training/Cons. in min:
A training duration of 20-30 Minutes is recommended.

Continue to the next level (%):
The percent rate of the correct decisions in reference to the total number of the objects shown is set. The level of difficulty is then increased when this rate is exceeded.

Repeat previous level (%):

As above, the percent rate of the correct decisions in reference to the total number of the objects shown is set. The level of difficulty is then decreased when the result falls below this transgression rate.

Number of objects:
The number of the objects which appear during a task on the assembly line is clearly defined. The choice of the number of objects depends on the status of the patient. For weaker patients, it is recommended to set the number of objects to 50 at the beginning. After performance consolidation it is recommended that default value of 100 objects should be set up once again. For high performance patients, an increase of the number of objects of up to 250 is recommended. In this case, the rate of the assembly line should also be set to "fast".

Ratio of incorrect objects:
The percent ratio of the incorrect / defective objects in relation to the number of objects can be set between 5 and 80% .
With a decrease in the percent ratio of incorrect objects, the type of training concentrated on here is **Vigilance**, whereas an increase in the number of incorrect objects is more specific to continuous concentration. In this way, the therapist has the possibility to train both categories. If **continuous concentration** is to be trained, it is recommended that the ratio of wrong objects should be set at 50%.

Type of objects:
The type of objects "**concrete**" or "**abstract**" can be selected (see the structure of the level of difficulty). In general it is recommended that the training should be used with the object type"**concrete**". In this way the procedure closer reflects reality, thereby increasing the motivation levels. Patients who have previously worked with "boring" procedures have seen great improvements here. For weaker patients who have had a problem with differentiation, the "abstract" objects should be used at the beginning of the training. However, with improvement in performance one should switch to the level for concrete objects.

Speed:
The speed of the objects on the assembly line can be varied. The slower the assembly line, the more concentration on vigilance. The faster the assembly line then the level of difficulty is higher and the training is more concerned with continuous concentration.

Acoustic feedback :
When activated, every reaction of the patient is combined with a RehaCom-typical audio sequence, depending on the quality of the reaction (wrong or correct decision). In general this option should be activated. However, this may cause interference.
Therefore, the acoustic feedback should be deactivated for high performance patients. Similarly it is recommended that the acoustic feedback should be deactivated if there are a lot of patients working in the one room.

Visual feedback :
In general the visual feedback should also be activated. A red or green lamp signals the quality of the decision.

Feedback Text/ Automatic stop:
When the facility 'stop the assembly line in the case of error' is activated, this allows the patient to analyse their errors in a better way. The patient can continue the training by pressing the OK-key. The automatic stop facility supports this type of training of **Vigilance**, especially at the beginning of the training. The particular differences between the standard objects and the erroneous objects is clearer for the patients at this stage. The disconnection of this option complicates the training and is better suited to high performance patients.

Particularly high demands are made on high performance patients when **all of the feedback facilities are deactivated**. Only at the end of a task is the patient informed as to how well the performed. This option is seen to cause additional stress in many patients. The procedure vigilance would be rather monotonous, if there were no interruptions during the training.

When setting up the procedure Vigilance, the computer determines the time which an object requires by means of the available technology (processor service, graphic card and so forth) to move across the screen from the left to the right. This time is stored and the average duration of a task computed from this. This average is increased if the patient makes mistake or inserts a break.

With a new set up of the training the following defaults are automatically installed:

Duration of Training	20 min
Continue to the next level	99 %
Repeat previous level	96 %
Incorrect objects	10 % (Training of Vigilance)
Number of objects	100
Type of objects	concrete
Speed	slow
Acoustic Feedback	on([X])
Visual Feedback	on([X])
Automatic stop	on([X])

1.5 Data analysis

The diverse possibilities of data analysis for the determination of the further training strategy are described in the
RehaCom basic foundations.

In the pictures as well as the tables, alongside the setting for the trainings parameter, the following information is available:

Level	current level of difficulty
Training time (effective)	effective Training time
Pauses	Number of breaks by the patient
Number of objects	Total number of objects
Number of incorrect objects	Number of incorrect objects
overlooked	Number of errors "overlooked" (an incorrect object was overlooked)
incorrect decision	Number of "incorrect decisions" (a correct object was selected in error),
Interval	Reaction time between objects
Acquisition time	Time from the beginning of the task until the pressing of the OK key
Solution time	Assembly line time

It is then possible to advise the patient about particular short-comings.

Specific information regarding the training consultation can be printed.

2 Theoretical concept

2.1 Foundations

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

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

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

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

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

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

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

Periodic activation is defined as the ability to increase the activation level for a subsequent reflex situation, rapidly reacting to a warning impulse (reflex readiness, Alertness), while for a relatively long time, stable attention level, **tonic activation** is designated.
The term **selective attention** focuses the action of reacting in a designated manner to specific aspects of a task, as it permits in a simultaneous manner fast reaction to relevant stimulus and also chooses to ignore irrelevant stimulus. This ability for the selection and integration of a defined stimulus or perception contents is narrowly associated with the term of the concentration ability; it is later defined as short-term, several minutes of continuous stimuli, acting together and restricting attention with selective recording of relevant features of the given situation (cf.Sturm, 1990).
Tasks which require **divided attention** must include at least include two sources of stimulation and these stimuli must be considered in parallel with each other, and so may react to relevant impulses occurring simultaneously or sequentially. For example , if a motorist is driving his car through overcrowded streets in rush hour, and in this case enters into a discussion with the co-driver. If these stimuli encounter the senses at a great rate, it most likely that mistakes will occur: the performance ability is therefore decreased.
This function is the subject of the present training program.

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

The attention compared to relevant environmental stimuli is dependent on internal *variables in the organism* (physiological status, cognitive processes, emotions) and external factors (impulse strength, contrast, strength of colour, delineation technique, spatial relationship and so forth).

Attention can be focused automatically which is non-random through especially intense or novel impulses (with high information content) by a orientation reflex - cognitive processes modulate the current *attention status* through thoughts, motivations and interest. In particular the selectivity of attention is maintained(or not maintained) in a controlled manner constantly by emotional evaluations and through a motivation processes.

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

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

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

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

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

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

2.2 Training aim

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

A specific aim of the programme vigilance is to improve the patient's performance in the area of tonic attention, with specific attention focussed on maintaining visual vigilance, in difficult observation situations (e.g. the continuous observation of a radar screen through an air traffic controller or the check of an industrial plant).

In the current training programme the patient's reaction skills are put under pressure in that they are also exposed to irrelevant information.

The training procedure aims to stabilise vigilance and improve the patient's attention skills (duration of attention). In the training task, a monotonous series of similar optical signals are presented. In this stimulus continuum, depending on the individual set up of the programme, relatively rare objects can appear in order to test vigilance, and objects which occur more often can be used to test continuous concentration. In addition alien and/or different deviations can also be used. Demands are made at the same time on the extent of the objects (increasing number of elements to be considered) and the flexibility of the focus of attention (alternation of the tasks). In this case, it is especially problematic to maintain the motivation of the patient during training.

As a result, the mnemic ordering is minimized in that, the objects which have to be matched are constantly visible during the task. The patient motivation to work with the procedure is increased the more the programme reflects reality.

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

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

Therapeutically, it is favourable, that along with the confrontation of existing deficiencies in information interference and individual *Coping and Compensation strategy* development; (for example the prevention of particular **stresses** or the use of external help by association with specific standard situations). Here relatives could also assist in order to reduce stress levels.

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

On the basis of the first results - and/or. the continuous diagnostic, it should be decided whether the training procedure Vigilance (VIGI) should be used alone, or in conjunction with other procedures. (e.g. **Attention and concentration** (AUFM), **Divided attention** (GEAU), etc.).

2.3 Target groups

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

Conceptually, it is assumed that different functions in attention can be selectively damaged. Brain damage of undetermined origin after traumatic or hypoxic aetiology leads to mostly specific deficiencies in attention, like rapid fatigue, increase in the need for sleep, and a general loss of motivation, whilst after localised strokes, for example of a vascular nature, specific disturbances in attention are often to be observed. According to the basic principles strokes in the cortexareale can lead to impairments in attention. After injuries to the brain stem, in the region of the reticular formation and parietal right sided injuries, problems are very noticeable in periodic and tonal alertness, as well as in vigilance. On the other hand, left sided parietal injuries damage the selective attention services earlier; in particular in the case of tasks in which decisions must be made between several stimulating or reflex alternatives (Covert shifts of Attention) (cf.,Sturm1990).

Assuming all the specific deficiencies of the different aspects of attention have been taken into consideration, then this training procedure could also be used.
This particular procedure is suited to patients who suffer from disturbances to the area of tonic attention: vigilance and continuous attention.

According to the premise of maximum specificity and in order to achieve the highest possible efficiency of training, the therapy plan should be prepared with a computer-assisted procedure, preceding to a differentiated neuropsychological diagnostic.

Numerous test results are available in order to evaluate the RehaCom procedures, some employ several training procedures simultaneously.

Vigilance was evaluated on patients with vascular brain injuries, trauma and dementia, through the following studies: Friedl-Francesconi (1995), Höschel et al. (1996), Liewald, (1996), Preetz et al. (1992), Regel & Fritsch (1997). Improvements in cognitive services in the raised tests (Pre-post comparison) and in part improvements in everyday life activities have been recorded.

In Beckers study (1992) used a training battery for SHT patients who have been diagnosed with disturbances to vigilance- and applied memory.

After 6 weeks of daily training, one could see significant improvements in the learning curves and significant increases in efficiency in the standard tests.

The procedure can be used with children up to the age of 14, and in this case appropriate instructions should be used. The touch screen is the recommended form of use for the procedure, in the case of children. At the moment at the Social-pediatric Centre in Magdeburg, this procedure is currently being tested by healthy kinder garden and school children. The results have yet to be publicised.

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