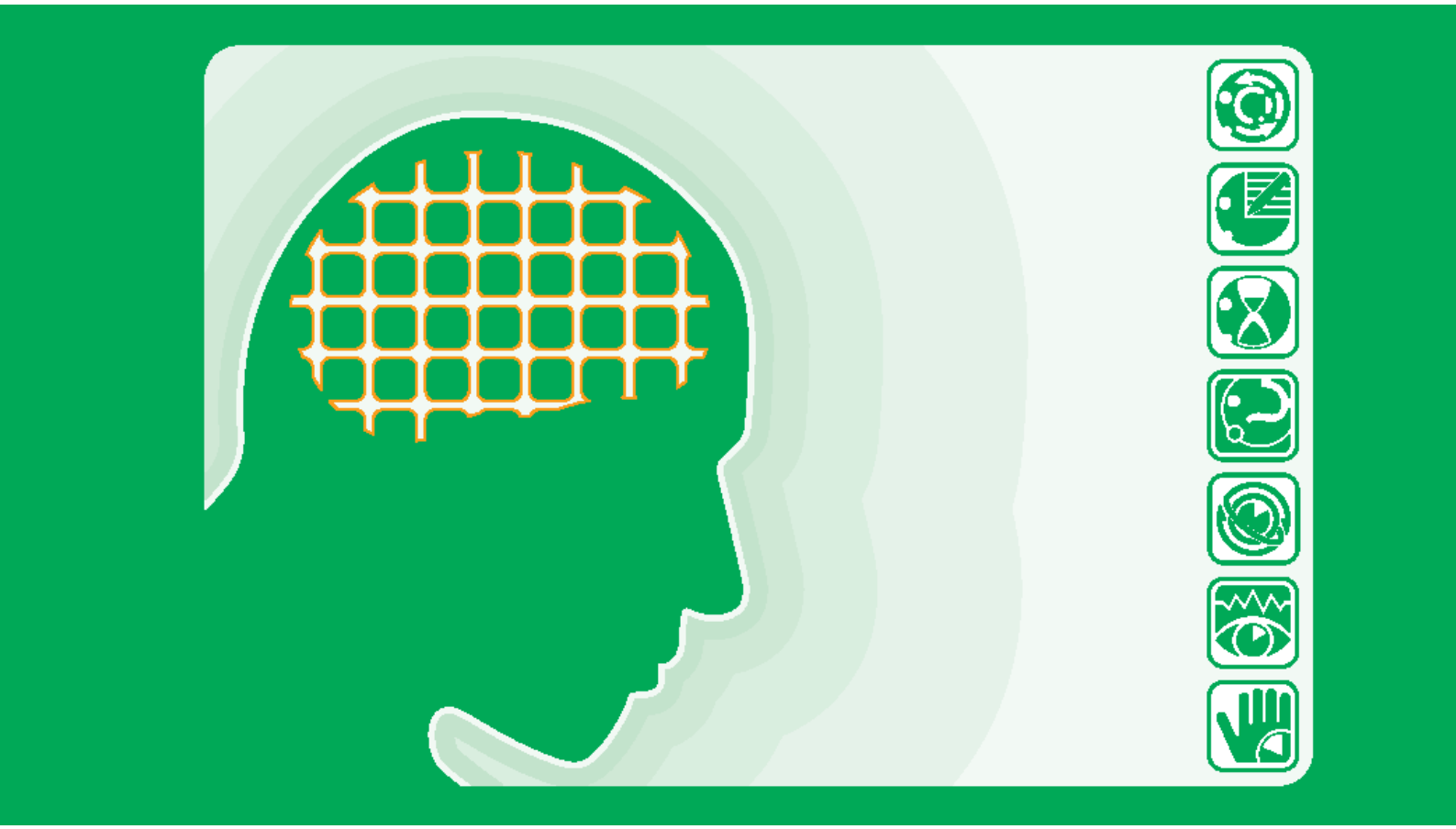
RehaCom

computer-assisted cognitive rehabilitation - brain performance training



Reaction behavior

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HASOMED®

Hard- und Software für die Medizin

RehaCom®

computer-assisted cognitive rehabilitation

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

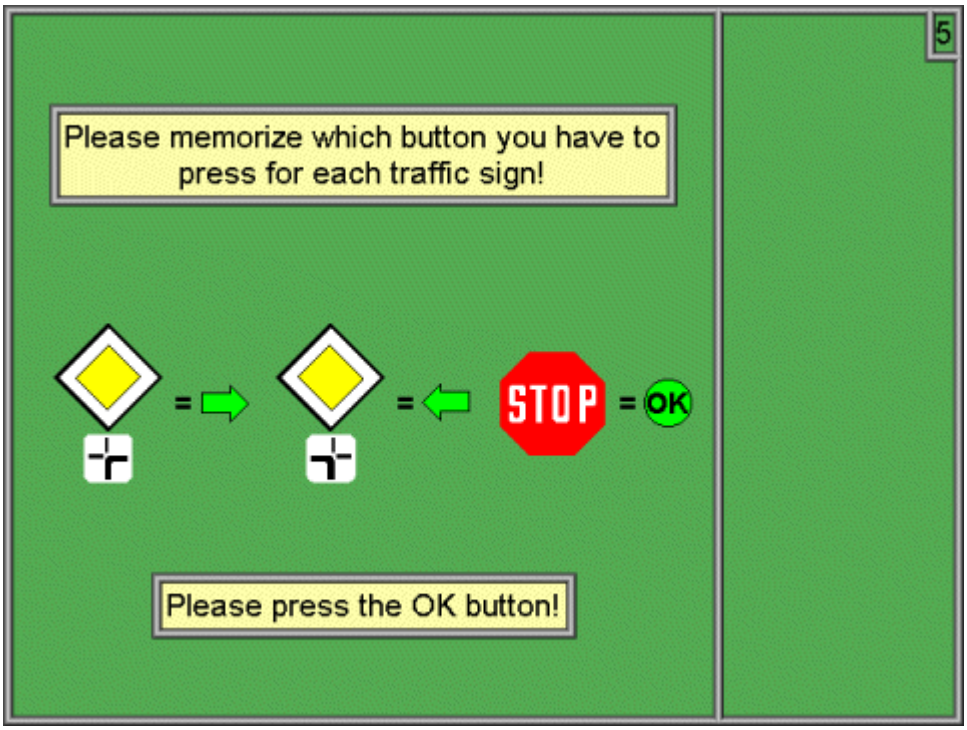
The training procedure 'Reaction behaviour' is quite realistic, in that it uses street and traffic signals. The task is to press the corresponding on the patient's panel whenever a target stimulus (i.e. a traffic sign) on the screen. In addition, there are also irrelevant signs ('different' traffic signs) which the patient mustn't react to. To reduce the memory components, the traffic signals and signs must only be associated with the panel. The following orders has been firmly established:

- Traffic signals, which have to do with directional information - turn ***right*** and/or ***left*** , are controlled with the keys "***arrow right***" and/or. "***arrow left***" on the patients panel.
- Traffic signals, which are associated with **stopping** (Stop sign, Yield right of way, red traffic light), then the patient has to react by pressing the ***OK-key***.

Each task has 2 phases:

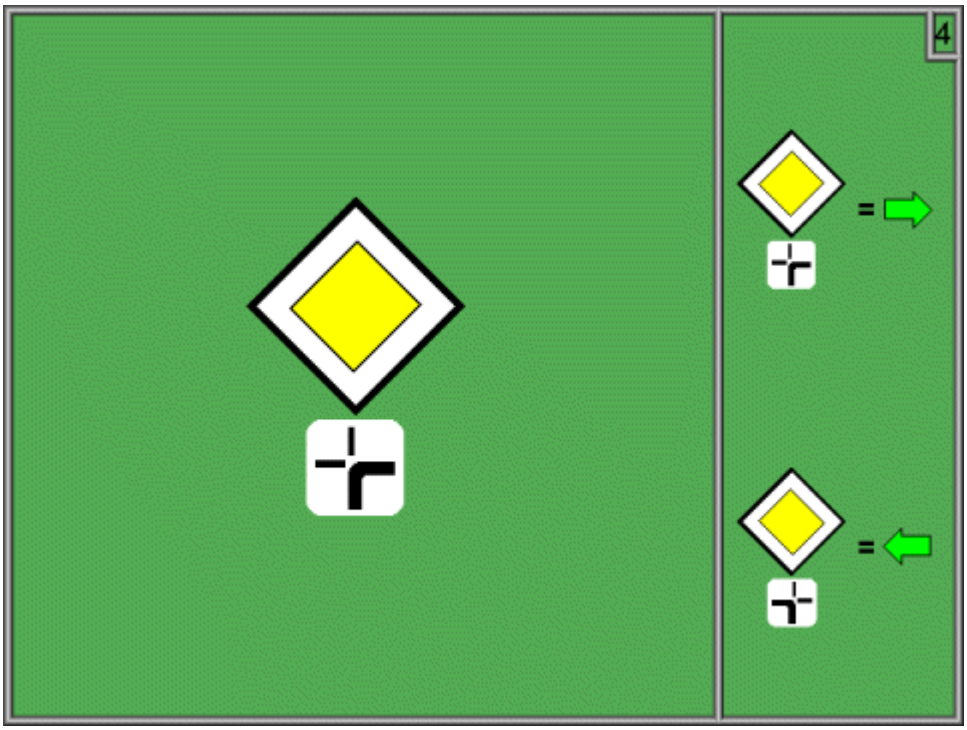
- the preparation phase and
- the reaction training.

During the preparation phase the patient makes themselves familiar with the task (Picture 1). He has to memorize the which traffic sign/stimulus has to be pressed in relation to the keys on the patient panel. The irrelevant stimuli which are used later in the training are not shown. The patient ends the preparatory phase by pressing the OK-key.



Picture 1. Preparation phase at Level 5.

The reaction training then follows (Picture 2). After the appearance of a traffic sign, the key on the patients panel assigned to the signal has to be pressed as quickly as possible. To minimize the strain on the memory the a key indicator is visible on the right hand edge of the screen. The patient should not react to irrelevant signals - those not learned in the preparation phase. Incorrect decisions are highlighted by an acoustic feedback or a visual feedback. The task is ended if the correct number of stimuli was shown for the number of defined traffic signs.



Picture 2. Reaction training at level 4. On the right the key indicator is continuously shown. The patient has to press the 'arrow right' key.

There are types of errors which can be made:

- reaction too late (Reaction time > maximum reaction time),
- no reaction to a relevant stimulus and
- incorrect reaction (incorrect key pressed in reaction to a relevant stimulus or the pressing of a key in reaction to an irrelevant stimulus).

Before every training task, level defendant instructions are provided for particular activities (see structure of the levels of difficulty). A "Learning by doing" instruction stage helps the patient to quickly acquire the purpose of the task.

1.2 Performance feedback

When the acoustic feedback is activated in the Parameter-Menu, an acoustic signal appears after each incorrect decision.

The type of signal for each type of error is different. The visual feedback changes the colour (from green to red) of the background momentarily. Correct decisions are not registered.

Too slow reactions are dealt with as incorrect decisions. In order to avoid irritation the feedback can be deactivated.

At the end of each task the patient is informed as to how they performed in relation to how many errors they made and if the reaction time speed needs to be altered. Advise as to whether the patient should proceed to the next level is also given.

1.3 Level of difficulty

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

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

In **tasks type 1** the next stimulus appears only after a reaction from the patient. **The patient establishes the speed at which he works**. After a reaction there is a stochastic time period until the next stimulus appears. This time period can be set up in the parameters - period between stimuli +/-50%. A relevant traffic sign stays on the screen until there is a reaction from the patient. An irrelevant signal disappears after the -period between stimuli- time level has been reached.

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

In task type 3 the time between stimuli alters in an adaptive way, which is **defendant on the quality of the patient's reactions**. The period between appearance of stimuli reduces after correct reactions and increases after incorrect reactions. As per irrelevant stimuli there is no change in the time period if the patient did not react to this irrelevant stimulus. Here, there are higher demands made on the reaction time and the patient's ability to discriminate between the signals.

In Table 1 16 different levels of difficulty are clearly defined.

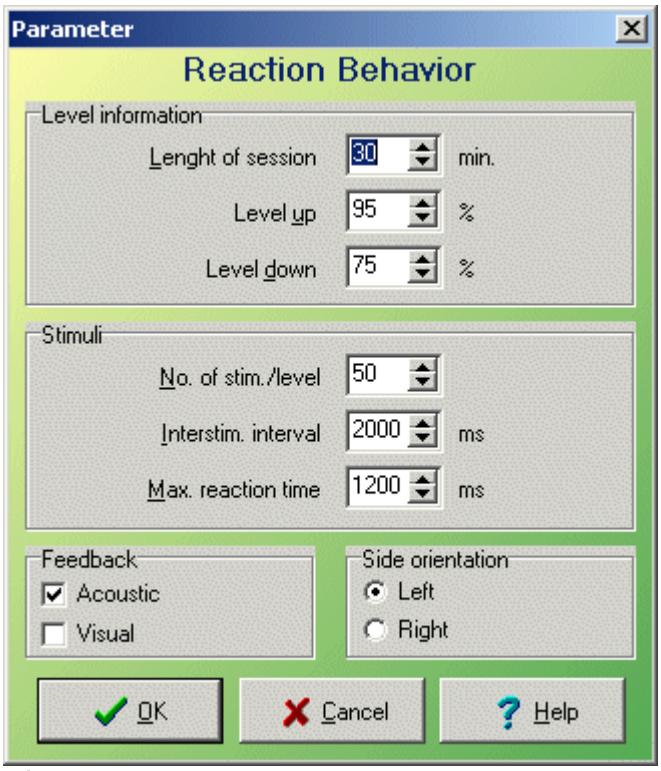
Table 1:
Structure of the level of difficulty

Level	***Type***	***Description***
1	1	Simple reaction without irrelevant stimuli, stimulus central, associated stimuli (traffic signals - of a stop function nature -reaction key is the OK-key).
2	1	Simple reaction with irrelevant stimuli, stimulus central, Use

		of non associative stimuli (no connection between signs and keys.) As irrelevant stimuli, traffic signs which deviate from the shaping and colour group of the described traffic signs are used. For example: for danger signals (Triangle, Arrow up, red) the OK-key should be pressed.
3	1	choice of 2 reactions without irrelevant stimuli, stimulus central, associative stimuli (Directions), For example: Traffic sign "course of the street" turn right and left connected to the task of pressing the 'arrow right' and or the 'arrow left' key on the RehaCom panel.
4	1	choice of 2 reactions with approx. 50% irrelevant stimuli. stimulus central, associative stimulus (Directions). The irrelevant signals do not contain any directional information, (e.g. "Parking" or "Petrol station").
5	1	choice of 3 reactions with approx. 50% irrelevant stimuli, Stimuli stochastically distributed throughout the screen, associative stimuli (Directional and Stop-information).
6	1	choice of 3 reactions with approx. 50% irrelevant stimuli. associated and unassociated stimuli (directional, stop and unspecific information).
7	2	as per Level 3, choice of 2 reactions without irrelevant stimuli
8	2	as per Level 4, choice of 2 reactions with irrelevant stimuli
9	2	as per Level 5, multiple choice reaction
10	2	as per Level 6, choice of 4 reactions
11	3	as per Level 4, choice of 2 reactions
12	3	as per Level 5, as per Level
13	3	as per Level 6, multiple choice reaction
14	3	as per Level 4 but without irrelevant stimuli (constant reaction required)
15	3	as per Level 5 but without irrelevant stimuli
16	3	as per Level 6 but without irrelevant stimuli

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 3 shows the parameter-menu.



Picture 3. Parameter-menu.

current level of difficulty:
The difficulty can be set up between the levels of 1-16.

Duration of training/Cons. in min:
A training period of 30 minutes is recommended.

Continue to the next level/ repeat previous level:
After completion of a task in task type 1 and 2 a percentage value is calculated - the percentage of correct decisions in relation to the number of stimuli. The next level is activated when the percentage calculated exceeds the value for 'continue to the next level'. This value should be reduced if the patient continues to have difficulties over a long period of time. This helps maintain the patient's motivation. An increase in this level makes it more difficult to jump to the next level. A patient has to return to the previous level when the percentage value is less than the value established for 'repeat the previous level'.
For task type 3 alteration of level is decided after completion of a task. The patient goes to the next level when reaction time between stimuli is less than 60%. Otherwise the patient has to repeat the previous level.

Number of stimuli/Level:
The number of relevant and irrelevant traffic signs which are shown in any given task is clearly established. When working in task type 3 the number of stimuli

should not be less than 100. This guarantees a type of 'tuning' for the "middle time period between stimuli".

Time period between stimuli (ms):
The parameters for the type of tasks have different meanings.
In the case of task type 1, the period between stimuli is calculated as the time of reaction by the patient up to appearance of the next stimulus.
(Inter-stimulus-interval = period between stimuli +- 50%). In the case of task model 2, the period between stimuli is calculated as the time from the start of the first stimulus to the start of the second stimulus.
If within the given time there is no reaction to a correct stimulus - it is evaluated as incorrect and the next stimulus appears.
In the case of task type 3, the time period between stimuli is the initial value for the "middle time period". After correct reactions, the time period between stimuli is reduced by 5%, and in the case of incorrect reactions or omissions the time period between stimuli is increased by 5%.

Maximum Reaction time (ms):
In task types 1 and 2 correct decisions are evaluated as incorrect when the time taken to solve them is outside the max. allowed reaction time. In task type 3 the maximum reaction time is used as the criteria for the level of difficulty at this level (see 'continue to the next level').
An increase of the "maximum reaction time" should be carried out if the emphasis in the training is placed on the quality reactions and not on time which my act as a stress factor.
However, the parameter should be reset to the default value when the patient improves
A decrease in this parameter acts as a stress factor.

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

Visual Feedback:
The green background changes to red for a short period after incorrect decisions. In general the acoustic feedback should always be activated.

Orientation:
In order to compensate for lateralization in patients the right/left training fields can be exchanged. This option can also be used for patients with a particular screen preference. (e.g. due to Neglect).

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

Current level of difficulty	1
Duration of training	30 min
continue to the next level	95 %
repeat previous level	75 %
number of stimuli	50
maximum reaction time	1200 ms
period between stimuli	2000 ms
acoustic feedback	on [X]
visual feedback	off [ ]
Orientation	left

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
#. rel. / irrel. stimuli	Number of relevant stimuli and number of irrelevant stimuli
#. Error Reaction time	How often was the max. reaction time surpassed
#. Errors no Reaction.	How often was there no reaction to a stimulus
#. Errors incorrect reaction	How often was the wrong key pressed
#. Error total	Total errors (wrong key and too slow are calculated as single errors)
correct reaction	Number of correct reactions shown as percent
#. Reaction. Inter-stim.	Number of reactions in inter-stimulus-interval

There also follows the Parameters reaction time Quartile 1, reaction time Median and reaction time Quartile 3, with Quartile 1 and 3 as well as Median reaction time in mins. Only reactions to relevant stimuli are used.

In this way it is possible to give the patient advise on their short-comings.

2 Theoretical concept

2.1 Foundations

The reaction behaviour procedure presupposes complex psycho-physiological performance skills which allow individuals to react in specific manner to particular external stimuli. Phasic attention parameters have a big role to play in the procedure reaction behaviour.

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.

In relation to the above 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. (cp. Sturm et al., 1994).

The ability to observe attention represents a basic assumption for a general capability with regard to different cognitive orders.

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 an orientation reflex

Sternberg (1969) (cf.Keller & Grömminger, in 1993) distinguishes four stages in his **action oriented model of attention** :

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.

With each reaction more phases can be distinguished:

. Increase of attention level in expectation of a stimulus.

- Presentation of stimulus.
- Latency phase
- Decision time
- Motor action.

Reaction time is the description for the time period between the processing of the stimuli and the carrying out of a simple motor reflex. It consists of the **latency time** (duration of the excitement management in the nervous system) and the **decision time** (duration of information processing) (Fröhlich, 1987).

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

Münsterberg (1924) makes a distinction between ***simple- and choice-reactions***. In referring to choice reactions he refers to:

- simple choice reactions with which several stimuli are presented, however one should only react to crucial stimuli
- Multiple choice reactions with which one should react differently to several crucial stimuli.

The reaction to critical stimuli with multiple choice reaction is influenced by additional factors:

- Type of stimulus / signal (acoustic, optical, thermal, etc.),
- Type and degree of difference between the signals,
- Rate of appearance of relevant / critical stimuli,
- The possibility of associative coupling between stimulus and reaction.

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.

Disturbances to attention include parameters like *slowness of reaction* and an increased error count, in different tasks. ***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). Disturbances to the reaction capabilities are found in approx. 70% of patients.

Above all a slowing-down in reaction - and/or the information processing speed is often observed (Poeck, 1989; Sturm, 1983; Säring, 1988; Benton, 1986). Regel (1981) considers the cognitive slow-down to be a main symptom of cerebral

influence.

In the psychological performance diagnostic, in particular in clinical-neuropsychological diagnostic, tests have a firm place for the examination of attention *and reaction capabilities* (Zimmermann & Fimm, 1989).

The attention fields mentioned at the beginning can be separated diagnostically through different tasks.

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

- 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).

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

2.2 Training aim

The aim of the training **Reaction behaviour** is to improve the patient's **exactness and the speed of their reactions** in relation to a set of given visual stimuli. By using simple and multiple choice reaction tasks, the patients reactions to given stimuli is trained. The patient should react as fast as possible to a set of traffic signals; in this way the procedure reflects a high degree of reality. During this training is - as a precondition for a reaction - the selective attention, i.e. the ability for focusing attention on specific information within irrelevant information, is trained in the visual modality. The memory aspect of the procedure is minimized by the assignment of the signals to reaction keys on the panel, which are fixed, except for few exceptions in training.

More recent research results recommends a differential training approach, which deals with specifically targeted disturbances in attention, as less theoretically based or unspecific procedures have not been successful in all aspects of attention(Gray & Robertson, 1989; Sohlberg & Mateer, 1987; Poser et al., 1992; Sturm et al., 1994; Sturm et al., 1997).

The procedure reaction behaviour is also in relation to deficits of selective attention not indexed with a general slowness of reaction.

Training makes demands on the patient's cognitive flexibility and with practise, can have a positive influence on the patient's motor skills (and apraxia).

Furthermore, - as with all cognitive tasks - after a particular time period demands are also put on the patient's continuous attention capabilities.

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.

From a theraputic ponit of view, 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.

On the basis of the first results - and/or. the continuous diagnostic, it should be decided whether the training procedure **Reaction behaviour** (REVE) alone, or in conjunction with other procedures. (e.g. **Attention & Concentration** (AUFM) **Divided Attention** (GEAU), **Vigilance** (VIGI), usw.).

2.3 Target groups

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

Disturbances in reaction capabilities can occur after modal specific or unspecific neuropsychological illnesses. This is also true for disturbances in attention.

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

localized strokes, for example of a vascular nature, specific disturbances in attention are often to be observed. According to the basic principles strokes in the cortex areale 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 areas of phasic activation and selective attention.

Patient's who suffer from a type of motor sickness (e.g. partial paralysis) have the possibility to train their reaction speed with their dominant or healthier hand.

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

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.

Excluded from the diagnostic are amongst others:

- serious visual deficits and
- strong disturbances in attention.

The procedure can be used with children up to the age of 14, and in this case appropriate instructions should be used.

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