HASOMED

RehaCom®

Cognitive therapy

Acoustic Responsiveness

www.rehacom.com

HASOMED
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).

Germany / Europe / Worldwide:
HASOMED Hard- und Software für Medizin Gesellschaft mbH
Paul-Ecke-Str. 1
D-39114 Magdeburg

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

Dear user,
please read the entire instruction manual before trying to operate RehaCom.
It's unsafe to start using RehaCom without reading this manual.
This manual includes lots of advice, supporting information and hints in order to reach the best therapy results for the patients.

Table of contents

1 Training description

1.1 Training task

The training of Acoustic responsiveness is carried out through single, choice, and multiple choice reactions. After the appearance of a defined acoustic stimulus a particular button on the RehaCom Keyboard has to be pressed as quickly as possible.

Training with Acoustic responsiveness is possible ***purely acoustically*** - without any visual information - and can therefore be used in blind or strongly visually impaired clients as well. Sounds and speech are generated by a soundcard which is essential for the training. The client's earphones are connected to it.

Before the training the basic volume is client specifically adjusted with the Windows loudspeaker. It is situated on the lower toolbar and only needs a mouse click to open up. To check the volume in RehaCom itself, press **System**, then **Volume RehaCom** (see also **Basic manual RehaCom**).
This holds for headphones. Loudspeakers usually have a volume button.

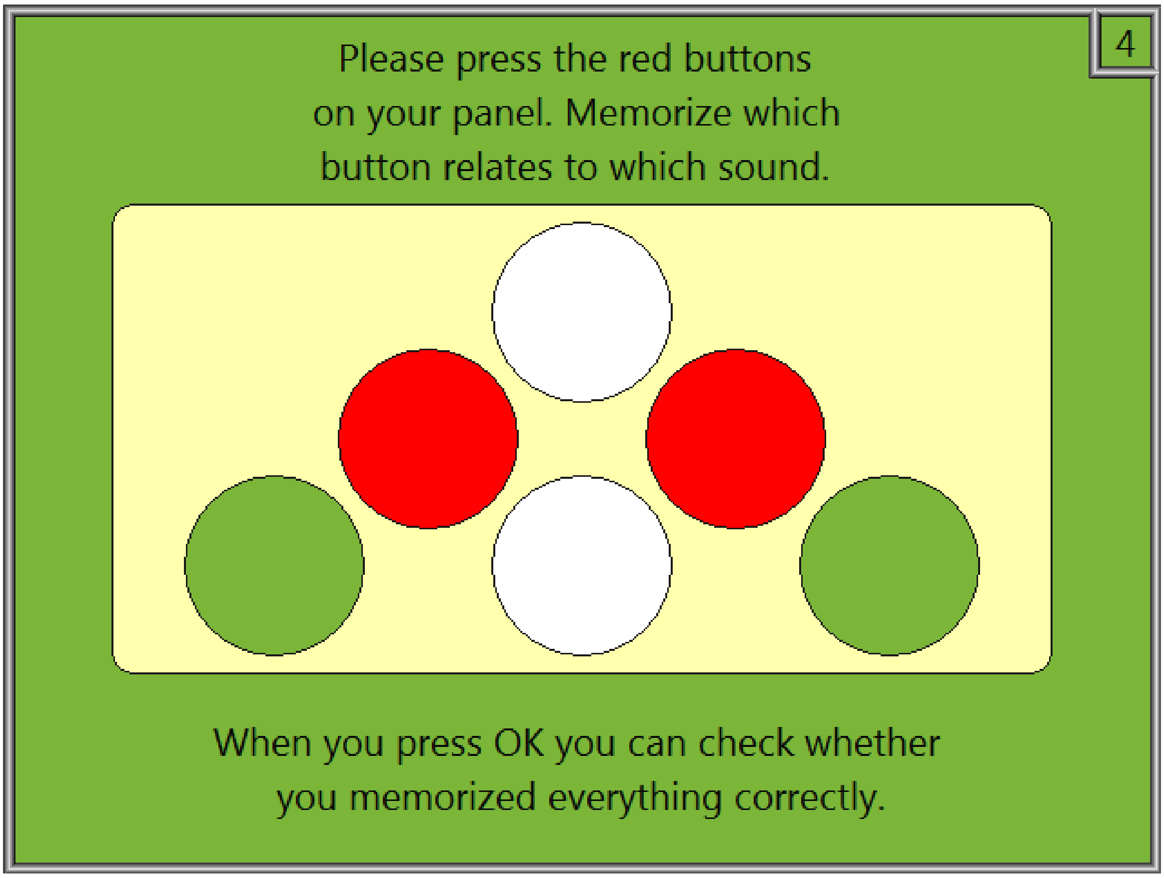

Fig. 1: Acquisition phase

Every task consists of 2 or 3 stages:

- acquisition,
- practise (if activated in the parameter menu) and
- training.

In the stage of acquisition, the RehaCom keyboard is displayed on the screen with particular buttons marked red (see Fig. 1). By pressing these buttons on his/her keyboard the client learns which sound corresponds to which button. Visually impaired people simply press the big buttons on their keyboard to learn the relations. "White" buttons require no reaction. Irrelevant stimuli which occur in higher levels are not introduced. The stage of acquisition is finished by pressing the **OK** button.

If the option ***Practice*** is enabled in the parameter menu, a short stage of practicing follows. It is identical with the later training, except that the process data (reaction time and quality) are not registered. After hearing 5 relevant stimuli, the stage of practice is finished and the keyboard (see Fig. 1) is displayed once more. Once again the client can check which button corresponds to which sound.
After pressing **OK**, the training starts.

When hearing a ***relevant stimulus***, a particular button on the keyboard has to be pressed as quickly as possible.
When hearing an ***irrelevant signal,*** the client must not react.

The following errors can occur:

- reaction to an irrelevant stimulus,
- no or too late reaction to a relevant stimulus (reaction time longer than maximum reaction time), and
- wrong reaction to relevant stimulus (wrong button).

Furthermore reactions during the stimulus interval are registered as "forbidden", however, they are not reported and estimated. Only the results show these errors.

During the training, a picture is seen on the screen which creates an atmosphere, and a surrounding context for the sounds (see Tab. 2). At the start of the training, the context is announced additionally (e.g. "On the beach").

If there are several clients training in one room, headphones should be used.

The module also works without a RehaCom keyboard. However, this mode is not recommended. The computer keyboard might be damaged.

1.2 Performance feedback

The feedback is carried out acoustically and/or visually.
If the acoustic feedback is enabled, errors are announced with the spoken words "wrong", "faster" or "too slow".
Visual feedback is given through a big field with the words "wrong" or "too slow" appearing after an error for a short time.

Furthermore a performance bar, situated on the left, grows with every correct reaction. The red mark on the bar represents the borderline between level down and going on training in the same level. Equally, exceeding the green mark (see parameter level up) means going over to a higher level task.

In the upper right corner of the screen the current level is shown.

After every task, the client is told about the outcome of his/her performance. This refers to mistakes as well as hints whether he/she worked quickly enough.

Especially worth mentioning is the practice mode in which the client can prepare the next task without pressure.

1.3 Levels of difficulty

level	no. rel. stimuli	no. irrel. stimuli	background sound	interstim. interval	used without irrel. stim.
1	1	0	off	100 %	yes
2	1	1			no
3	2	0			yes
4	2	2			no
5	3	0			yes
6	3	all			no
7	1	0	silent		yes
8	1	all			no
9	2	all			yes
10	3	all			yes
11	1	0	loud	100 %	yes
12	1	all		100 %	no
13	1	0		50 %	yes
14	1	all		50 %	no
15	2	all		100 %	yes
16	2	all		50 %	yes
17	3	all		100 %	yes
18	3	all		50 %	yes

19	4	all		100 %	yes
20	4	all		50 %	yes

Tab. 1: Levels of difficulty

The module works adaptively. The structure of difficulty results from the variation of

- the number of relevant and irrelevant stimuli,
- the volume of the background sounds (background/ foreground differentiation), and
- the duration of the interstimuli interval (full length or half length, and thus faster succession of stimuli).

If the parameter "Without irrel. stim." is enabled, all numbers of irrel. stimuli are set to 0.

A higher level is not necessarily more difficult but might train new skills.

The module consists of 6 groups of sounds with 9 sounds each (see Tab. 2).
Main object is that all sounds are recognized and associated by the client.

soundgroup	**sounds**
on the farm	cat, dog, sheep, horse, goat, cow, duck ...
on the beach	boat, dog, fog-horn, laugh, cry, music, horse ...
at home	window, gong, ring, dog, telephone, clock, baby ...
in the streets	car, brake, train, explosion ...
in the jungle	lion, elephant, shot, fall of a tree, bird, mosquito ...
musical instruments	trumpet, strings, flute, organ, piano ...

Tab. 2: Groups of sounds / surrounding context

1.4 Training parameters

Specific settings for the training module can be adjusted (see Fig. 2). This section describes each setting and explains how to adjust them.

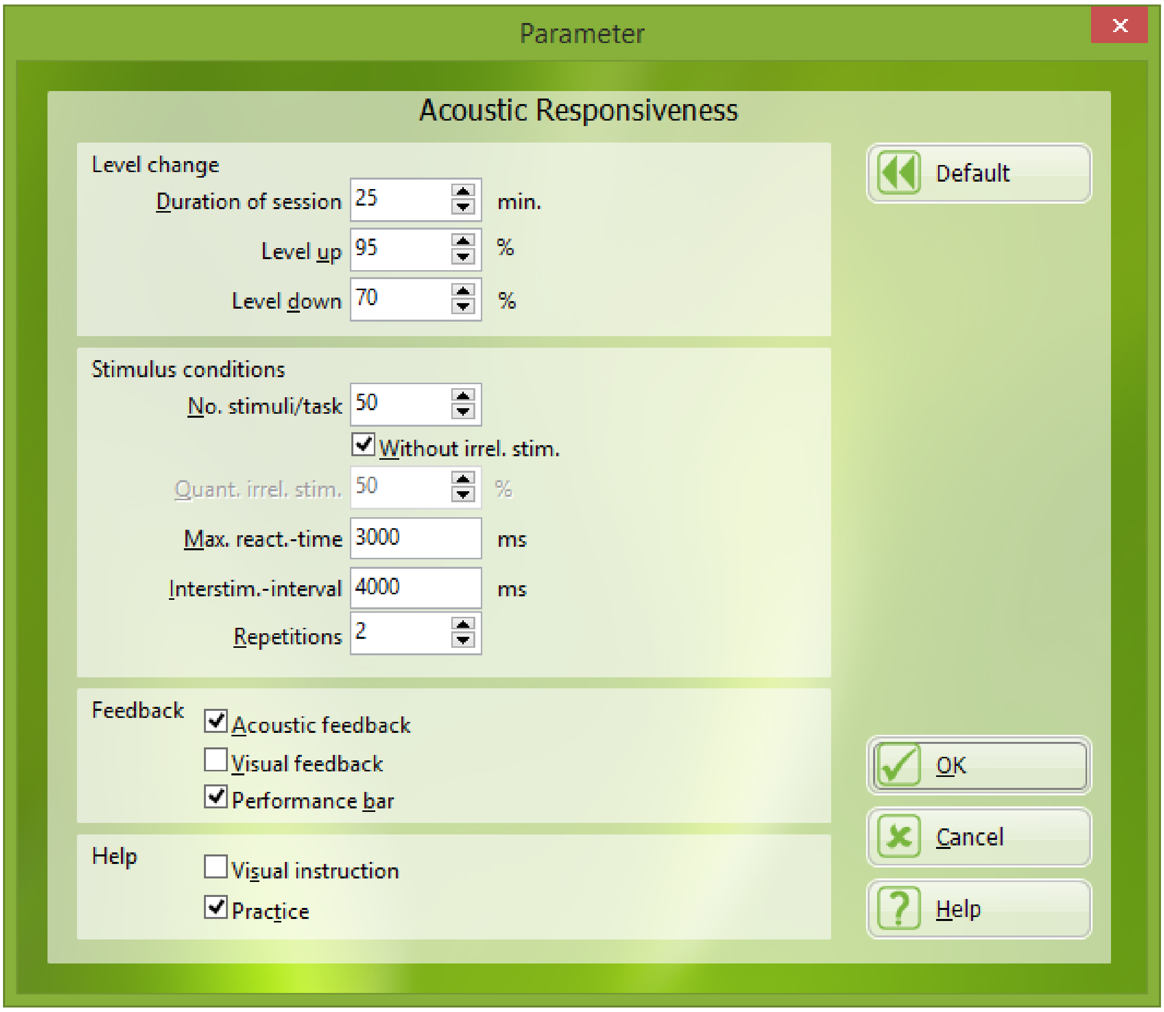

Fig. 2: Parameter menu

Duration of session:
Recommended are 20–25 minutes.

Level up / down:
Once a task is finished, the percentage of ***correct decisions in relation to the number of stimuli per task*** is calculated.
The next higher level is reached if the achieved percentage is higher than ***Level up***.
Level up should be set down if a client has worked at the same level for a long time and could be motivated through a change to a higher level. Increasing the value makes it harder to reach the higher level.

Level down
The lower level is reached if the percentage of correct decisions falls below ***Level down***.

Stimulus conditions
No. of stimuli/task:

The overall sum of relevant and irrelevant signals per task is set.

Without irrel. stim.:
If this parameter is enabled, training runs without irrelevant stimuli. Some levels of difficulty will be skipped in this mode.
If this parameter is disabled, training runs with irrelevant stimuli. The trainings uses full range of levels of difficulty.

Quant. irrelevant stimuli in %:
The percentage of irrelevant sounds in relation to the overall number of stimuli per task is generated. If it is low, the client has to react more often. However, irrelevant stimuli only appear if the percentage is higher than 0 (see Tab. 1). If the part of irrelevant stimuli is increased dramatically (e.g. 90%), the tasks appear rather like a training of vigilance.

Max. reaction time in ms:
If the reaction time for a relevant stimulus exceeds the ***maximum reaction time,*** the reaction is registered as incorrect.
This offers the training of particular skills. If the maximum reaction time is shortened, fast reactions are required. If it is longer, mainly the carefulness of the reactions is trained.

Interstimulus interval in ms:
The average interval between the disappearing of one stimulus and the appearing of the next one is generated (interval stochastically +- 50% of the interval). In particular, the interstimulus interval is divided in half for raising the difficulty levl (see Tab. 1). For weaker clients, the interval is recommended to be prolonged.

Repetitions:
It is generated how often in succession ***the same task*** (same context and same stimuli, with equal requirements) is given. In that way, the client can train repeatedly with a stimuli constellation he/she learned once (memory effect). If the number of repetitions is set to 0, every new task will have changed stimuli requirements. This only holds true for continuing on the same level. When going up or down, the counting of the repetitions restarts, and the stimuli conditions are set anew.

Feedback
Acoustic / Visual feedback, Performance bar
The different possibilities of feedback were described before.

Help:
Visual instruction
In general the module works purely acoustically. If necessary, the spoken instructions can also be displayed and read on the screen.

Practice
If this parameter is activated, the acquisition is intensified.

When newly defining a training, the system automatically uses the following default values:

Current level of difficulty	1
Length of session	25 minutes
Level up	95%
Level down	70%
No. stimuli/task	50
Without irrel. stim.	on
Part irrelevant stimuli	50%
Max. reaction time	3000 ms
Interstimulus interval	4000 ms
Repetitions	2
Acoustic feedback	on
Visual feedback	off
Performance bar	on
Visual instruction	off
Practice	on

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

Level	Current level of difficulty
Mistakes	Incorrect reactions to relevant stimulus
Mistakes irrel.	Incorrect reactions to irrelevant stimulus
Omissions	Late or missing reactions to relevant stimulus
Reac. interstim.	Unauthorized reactions during interstimulus interval
Acqui. time	Duration of acquisition in h:mm:ss
Quartile 1 reac. time	Reaction time quartile 1 in ms
Median reac. time [ms]	Median of all reaction times in ms
Quartile 3 reac. time [ms]	Reaction time quartile 3 in ms
Train. time task	Effective training time in h:mm:ss
Breaks	Number of breaks caused by the client

The parameter settings used during the training are displayed directly below the table. The graphical presentation of the results (correct decisions per task, median of all reaction times) is also displayed on the Table and Chart tab.

2 Theoretical concept

2.1 Foundations

Acoustic information, the incoming sound, is conducted from the Corti`s organ over a range of neural tracks via the brain stem to primary areas of the cerebral cortex. In the secondary cortical areas at the outside of the temporal lobe the acoustic stimuli are analyzed, identified and compared to former acoustic memories. The interpretation of sound wave sequences as sounds, tones, melodies, voices, words, sentences - which is speech - happens on the basis of this information analysis. So speech perception and the acoustic recognition of objects are closely connected to acoustic discrimination (volume, pitch, timewise and phonematic analysis) (Tallal & Newcombe, 1978).
During the cognitive processing of acoustic stimuli, the hemisphere counter-lateral to the ear is dominant (Efron,1990).

The ability to react towards acoustic stimuli by means of a motor action requires two basis 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
- telencephal 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 (2) can neuro-psychologically (3) 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 telencephal lesions, the impairment concerning simple psycho-acoustic parameters affects always the ear counter-lateral to the lesion, independent of the hemisphere dominance. These impairments can have different profiles according to each individual lesion (Efron, Yund, Nicholas, & Crandall, 1985). The capacity to filter out relevant acoustic signals 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 telencephal hearing disorders.

The basic symptom of central hearing disorders is the serious difficulty for clients to follow discussions if there are loud background noises or several persons talking in confusion. Often clients also report a changed or asymmetrical perception of sounds (cf. Blaettner & Goldenberg, 1993).
In contradiction to clients with peripheral hearing disorders, clients after serious telencephal 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 damages are often accompanied by aphasia, and - in case of sensoric aphasia - speech can not be understood in spite of intact sound and tone differentiation. In contrast, right hemisphere damages seem to cause worse performances in complex acoustic discrimination tasks (cf. Blaettner & Goldenberg, 1993). Reduced discrimination capacities also appear in left hemisphere damages 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 signal contains redundantly, and consequently a clear signal discrimination on the intact cortical level is no longer possible.

In deficits concerning the recognition of the meaning of non-verbal acoustic stimuli, one assumes that they are less the consequence of a disturbed acoustic discrimination capacity but rather deficits in the semantic memory caused by an aphasia (Goldenberg, 1992; Varney, 1980). Recognition disturbances manifest themselves, for example, in a raised number of errors when associating sounds with pictures of the noise source (cf. Blaettner & Goldenberg, 1993).
Because of the *disorders in the information taking*, every telencephal hearing disorder can lead to *deficits in the acoustic information saving* in the memory. The same holds true for attention and concentration disturbances which show up in a reduced *perception and processing capacity*, reduced *information processing capacity*, rapid signs of *fatigue* especially when strained, but also higher *delicateness to distraction.*

Attention disturbances mostly effect not only the acoustic modality. A special case of this disturbance is the neglect, which is the non-observance of stimuli on the side counter-lateral to the lesion. If the neglect phenomena appear only in the acoustic modality, they are the expression of a telencephal hearing disorder. Mostly however they are accompanied by visual and tactile disturbances indicating a superordinated functional disturbance (Heilman & Valenstein, 1972).

For a *differential diagnosis* of psycho-acoustic and/or neuropsychological deficits, a range of *tone and speech audio-metric, psycho-acoustic and electro-physiological procedures* can be used.
Frequency dependent hearing threshold tests, for the diagnosis of abnormal hearing adaption, are used for the metric recording of peripheral hearing functions; as well as speech tests or tests with sensitized speech.
Frequency-dependent hearing threshold tests, above threshold hearing tests and threshold tone decay tests for the diagnosis of abnormal auditory-adaptation serve the metrical capture of peripheral auditory functions; as well as monaural speech tests or tests with more sensitised speech.

For the central hearing diagnosis dichotic speech tests, nonverbal dichotic tests, tests of spatial hearing and of the timewise hearing perception (e.g. click fusion threshold) are indicated.
Physiologically the cerebral locality of processing disturbances of acoustic stimuli can be detected by means of event correlated brain potentials (acoustically evoked potentials (AEPs)). The stapidus reflex measuring will provide further information about a peripheral or central origin of the hearing disorder.

The ***reaction capacity*** requires complex psycho-physiological performances which enable the human being to react towards stimuli in a certain manner.
Phasic attention parameters are of special importance for the reaction capacity and can possibly hardly be distinguished from acoustic discrimination disturbances.
Phasic activation is defined as the ability to increase the general activation niveau quickly (and thus making further reactions easier) on an alarming stimulus (alertness), whereas an activation niveau relatively stable over a longer period is called ***tonic activation***.
Selective attention, which is also relevant in this RehaCom module, means focusing on certain aspects of a task and thus reacting to relevant stimuli quickly but simultaneously ignoring irrelevant ones. (cf. Sturm, Hartje, Orgaß, & Willmes, 1994).
Attention disturbances include parameters as e.g. *reaction deceleration* or a *raised number of errors* in different tasks.
The attention towards relevant environmental stimuli depends on many inner conditions (physiological state, cognitive processes, emotions etc.) and external factors (intensity of stimulus, contrast, color, spatial relation, etc.). Especially intensive or new stimuli (with high information content) can focus the attention automatically, which means involuntarily, through an *orientation reaction*.
For every reaction several stages can be distinguished:

1. raising of the attention level in expectance of a stimulus
2. stimulus presentation
3. latency phase

4. decision time
5. motor action

Münsterberg (1924) distinguishes between ***single and choice reactions***.
Amidst the choice reactions he counts:

- simple choice reactions: several stimuli are presented, but only one critical stimulus requires a reaction
- multiple choice reactions: a range of critical stimuli require different reactions

The reaction towards critical stimuli in multiple choice reactions furthermore depends on the following factors:

- kind of stimulus/ signal (acoustic, visual, thermal etc.),
- kind and degree of signal differentiation,
- appearance frequency of relevant critical stimuli, and
- possibility of associative coupling of stimulus and reaction.

Attention disturbances after brain damage of different locality and genesis are the most frequent neuropsychological performance deficits after damage of the brain (Van Zomeren & Brouwer, 1994).

Impairments of the reaction capacity are found in approximately 70% of the clients; most of all a *deceleration of the reaction or information processing speed* is observed in clients suffering from brain damage (Poeck, 1989; Sturm, Dahmen, Hartje, & Wilmes, 1983; Säring, 1988; Benton, 1986). Regel, Krause, & Krüger (1981) see the cognitive deceleration as basic symptom of the cerebral impairment.

The chapters training aim and target groups provide further information.

2.2 Training aim

The module **Acoustic responsiveness** aims at an improvement of the *reaction speed and precision* on acoustic signals, and at an improvement of the *acoustic discrimination and recognition capacity*. Through that quick differentiating, reactions on acoustic stimuli in everyday life (e.g. horn, alarm clock, telephone) are trained. Higher levels of difficulty want to simulate a complex acoustic surrounding, e.g. a traffic situation.
With a raising number of stimuli requiring a reaction, more and more the *memory capacity* (association of acoustic stimulus and button) is demanded.

This module trains - as prerequisite for a reaction - the selective attention, which is the ability to focus one's attention and simultaneously ignoring irrelevant information, in the acoustic modality.
Through the training of the acoustic reactivity, the recognition of sounds can be supported and trained simultaneously.

The training furthermore puts demands on the cognitive flexibility, and can through practice improve the motor and action confidence of the client.
Supplementary the reactivity can be trained with visual stimuli through the RehaCom modules **Responsiveness** (REA1), and **Reaction behaviour** (REVE).
Procedures training different specific attention deficits are **Divided attention** (GEAU), **Attention & Concentration** (AUFM), and **Vigilance** (VIGI).

2.3 Target groups

The use of the module **Acoustic responsiveness** is recommended for clients with ***deficits of reaction speed and reaction precision***, but also in ***disturbances of the acoustic discrimination, recognition and/ or memory capacity***. Impairments of the reaction capacity can appear modality specifically or unspecifically in all neurological diseases. Specific neuro-psychological deficits appear after damages of the brain stem or the temporal lobe or telencephal lesions. In telencephal lesions the client often has no longer access to his/her hearing perception, so a training of sound discrimination after clear, basic criteria (cf. Scherg, 1988) is recommended. In these disturbances one has to consider that the acoustic stimuli are presented in a volume pleasant to the client; speaking loudly, for example, often may lead to overstimulation.
Serious telencephal disturbances can occur after bilateral but also extended unilateral lesions of the temporal lobe. The main symptoms are a far-reaching loss of speech perception, of sound recognition and music perception; however isolated deficits may also occur (cf. Scherg, 1988). It has to be decided individually whether a training of the acoustic reactivity makes sense.
Less serious telencephal hearing disorders can lead to a reduction of the speech perception under harder hearing conditions (background voices). They must be distinguished from hearing problems of peripheral origin, such as the cocktail-party situation. Once more, one cannot give a general recommendation, individually you should try out the module.
Central hearing disturbances can be overlapped by aphasic disturbances (the lesion causing the aphasia often afflicts the hearing structures of the speech dominant hemisphere), especially in clients with localized damages of the temporal lobe in the left hemisphere. That makes the diagnosis as well as the realisation of therapeutical measures more difficult.
Peripheral and central hearing disorders may also occur mingled, particularly in clients with traumatic brain injury.
For clients suffering from cerebral hearing disorders, situations requiring the recognition, tracing and identification of an acoustic signal are especially difficult. The same holds true for a higher delicateness to distraction.
Frequently the clients negate their hearing disorders, or estimate them as unimportant.
Clients with specific attention disturbances - especially of the selective attention - will profit from this module.
Fundamentally insults of any cortex area can lead to impairments of the attention.

Particularly after lesions of the brain stem in the area of the Formatio reticularis and after right parietal lesions, disturbances of the *phasic or tonic alertness* and of the *vigilance* can be observed. In contrast,
left parietal insults afflict rather the selective attention capacities.
In distinctive *dysexecutive syndroms*, especially after damages of frontal areas, the appealing character of acoustic stimuli can positively affect the reaction ability.
In clients with half-sided neglect, stimuli presented on the neglected side may be perceived if presented uni-laterally. However if stimulated bilaterally, these stimuli are neglected (extinction, cf. Blaettner & Goldenberg, 1993). Consequently it makes therapeutically sense to stimulate the client monaurally on the neglected side.
In serious brain stem hardness of hearing very often the speech perception is afflicted considerably. The sound discrimination can be lost or in deficit from the interruption of afferent connections in the brain stem.
Diagnostically excluded should be *serious impairments of the hearing capability*, *very serious acoustic discrimination disturbances* (serious telencephal hearing disturbance and serious brain stem hardness of hearing, in case of the latter all acoustic stimuli are experienced as monotonous, muffled sound) and *very far reaching attention deficits*, and the delicateness to distraction mentioned before. In central hearing disorders you should be aware of choosing a volume pleasant to the client, particularly if training with headphones.

On the assumption of maximum specifity and in order to achieve the optimum efficiency of the training, a *subtly differentiated neuro-psychological diagnosis* should be prerequisite for the making of a therapy plan including computer-based modules.

The module is suitable for partially sighted or blind clients.
The use in children from the age of 8 is possible as well. Up to the age of 14 child-friendly instructions are given.

2.4 Bibliography

Benton, A. (1986): Reaction time in brain disease: some reflections. Cortex 22. S. 129-140.

Blaettner, U. & Goldenberg, G. (1993): Hören. In: Cramon, D.Y. von; Mai, N. & Ziegler, W. (Hrsg.): Neuropsychologische Diagnostik. Weinheim: VCH.

Duus, P. (1990): Neurologisch-Topische Diagnostik. Stuttgart: New York: Georg Thieme Verlag.

Efron R. &v Crandall, P.H. (1983): Central auditory processing. II. Effects of anterior temporal lobectomy. Brain Lang., S. 237-253.

Efron, R., Crandall, P.H., Koss, B., Diveny, P.L. & Yund, E.W. (1983): Central auditory processing III: The "cocktail party" effect and anterior temporal lobectomy.

Brain Lang., 19, S. 254-263.

Efron, R. (1990): The Decline and Fall of Hemispheric Specialization. Hillsdale: New Jersey: Lawrence Erlbaum Associates.

Efron, R., Yund, E., Nicholas, D. & Crandall, P.H. (1985): An ear asymmetry for gap detection following anterior temporal lobectomy. Neuropsychologia, 23, S. 43-50.

Heilman, K.M. & Valenstein, E. (1972): Auditory neglect in man. Arch. Neurol., 26, S. 32-35.

Fimm, B. (1997): Microanalyse von Aufmerksamkeitsprozessen. In: Gauggel, S. & Kerkhoff, G. (Hrsg.): Fallbuch der Klinischen Neuropsychologie. Praxis der Neurorehabilitation. Göttingen: Hogrefe. S. 25-38.

Keller, I. (1997): Aufmerksamkeitsstörungen. In: Gauggel, S. & Kerkhoff, G. (Hrsg.): Fallbuch der Klinischen Neuropsychologie. Praxis der Neurorehabilitation. Göttingen: Hogrefe. S. 39-47.

Keller, I. & Grömminger, O. (1993): Aufmerksamkeit. In: Cramon, D.Y. von; Mai, N. & Ziegler, W. (Hrsg.): Neuropsychologische Diagnostik. Weinheim: VCH.

Münsterberg, H. (1924): Grundzüge der Psychologie. In: Ziehen, Th.: Allgemeine Psychologie. Berlin: PAN-Verlag.

Posner, M. & Rafal, R. (1987): Cognitive theories of attention and the rehabilitation of attentional deficits. In: Meier, M., Benton, A. & Diller, L. (Ed.). Neuropsychological rehabilitation. Edinburgh, London: Churchill Livingstone.

Poeck, K. (1989). (Hrsg.): Klinische Neuropsychologie. Stuttgart, New York: Thieme-Verlag.

Regel, H. & Fritsch, A. (1997): Evaluationsstudie zum computergestützten Training psychischer Basisfunktionen. Abschlußbericht zum geförderten Forschungsprojekt. Bonn: Kuratorium ZNS.

Regel, H., Krause, A. & Krüger, H. (1981): Konfigurationsfrequenzanalytische Einschätzung einiger psychometrischer Verfahren zur Hirnschadensdiagnostik. *Psychiatrie, Neurologie und medizinische Psychologie, 33.*

Säring, W. (1988): Aufmerksamkeit. In Cramon, D. v. & Zihl, J. (Hrsg.). Neuropsychologische Rehabilation. Berlin, Heidelberg, New York: Springer Verlag.

Scherg (1988): Hören. In: Cramon, D. v. & Zihl, J.(Hrsg.). Neuropsychologische Rehabilitation. Berlin, Heidelberg, New York: Springer-Verlag, S. 132-150.

Sturm, W. (1990): Neuropsychologische Therapie von hirnschädigungsbedingten

Aufmerksamkeitsstörungen. Zeitschrift für Neuropsychologie, 1 (1), S. 23-31.

Sturm, W., Dahmen, W., Hartje, W. & Wilmes, K. (1983): Ergebnisse eines Trainingsprogramms zur Verbesserung der visuellen Auffassungsschnelligkeit und Konzentrationsfähigkeit bei Hirngeschädigten, Arch. Psychiatr. Nervenkr. 233, S. 9-22.

Sturm, W.; Hartje, W.; Orgaß, B. & Willmes, K. (1994): Effektivität eines computergestützten Trainings von vier Aufmerksamkeitsfunktionen. Zeitschrift für Neuropsychologie, 1, S. 15-28.

Sturm, W.; Willmes, K. & Orgaß, B. (1997): Do Specific Attention Deficits Need Specific Training? Neuropsychological Rehabilitation, 7 (2), S. 81-103.

Van Zomeren, A.H. & Brouwer, W.H. (1994): Clinical Neuropsychology of Attention. Oxford: Oxford University Press.

Tallal, P. & Newcombe, F. (1978): Impairment of auditory perception and language comprehension in dysphasia. Brain Lang., 5, S. 13-24.

Varney, N.R. (1980): Sound recognition in relation to aural language comprehension in aphasic patients. J Neurol Neurosurg Psychiat, 43, S. 71-75.

Index

- A -

- B -

- C -

- D -

- E -

- F -

- H -

- I -

- L -

- M -

- N -