HASOMED

RehaCom®

Cognitive therapy

Screening: Visual Scanning

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HARDWARE AND SOFTWARE FOR MEDICINE

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).

CAUTION	Risk of misdiagnosis. Screening for use of RehaCom only. Use standardized tests for diagnostic.

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

Table of contents

1 Disorders of the visual field

The first step in visual information perception under natural conditions is to gain an overview of the current environment or "stimulus pattern." This "first look" contains a global coding of the outside world in the form of a coarsely structured scene, meaning that it already includes the essential information on the spatial structure of the scene as the basis for finding and processing relevant stimuli (e.g. objects or persons - see Fig. 1). The "relevance" of stimuli can be driven either externally by the conspicuousness of a stimulus (or bottom-up activation) or internally by the viewer's intentions (or top down activation). Usually it is a combination or interaction of externally and internally controlled processes, because prior knowledge of the current or expected environment and also intentions are practically always given.

An overview is obtained through the global processing of a scene. The neurobiological basis for that is represented by modules of the dorsal visual processing path, whereby the (right-sided) posterior parietal cortex might play a prominent role (Hochstein & Ahissar, 2002).

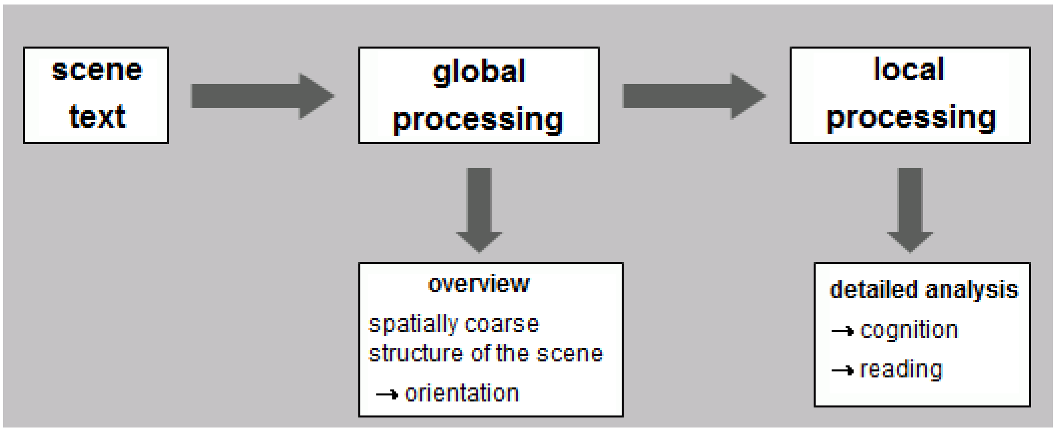

Fig. 1: Global and local visual information processing

When getting the overview of a scene, a person can find an object (target stimulus) easily and independently from the number of additional existing stimuli in the scene (distractors) if the difference between the two stimulus classes is sufficiently large. This is an example of parallel search. In general, one glance is enough to quickly discover the target stimulus, because it is easily discernible from the other stimuli. In contrast, a serial search mode is required in case the target stimulus and the distractors are similar (Müller, 2003). The attention field must be decreased accordingly, and the search time increases according to the number of distractors. The parallel search mode can thus be rated as a form of global processing, and the serial mode as form of local visual information processing.

Fig. 2 shows an example of scenes in which the global/parallel or the local/serial processing mode is applied. The resulting search times for the target stimulus

(triangle with the vertex pointing downwards) are each shown below. In the parallel search mode, the search time is independent from the stimulus density; in the serial search mode, however, search time increases with the stimulus density.

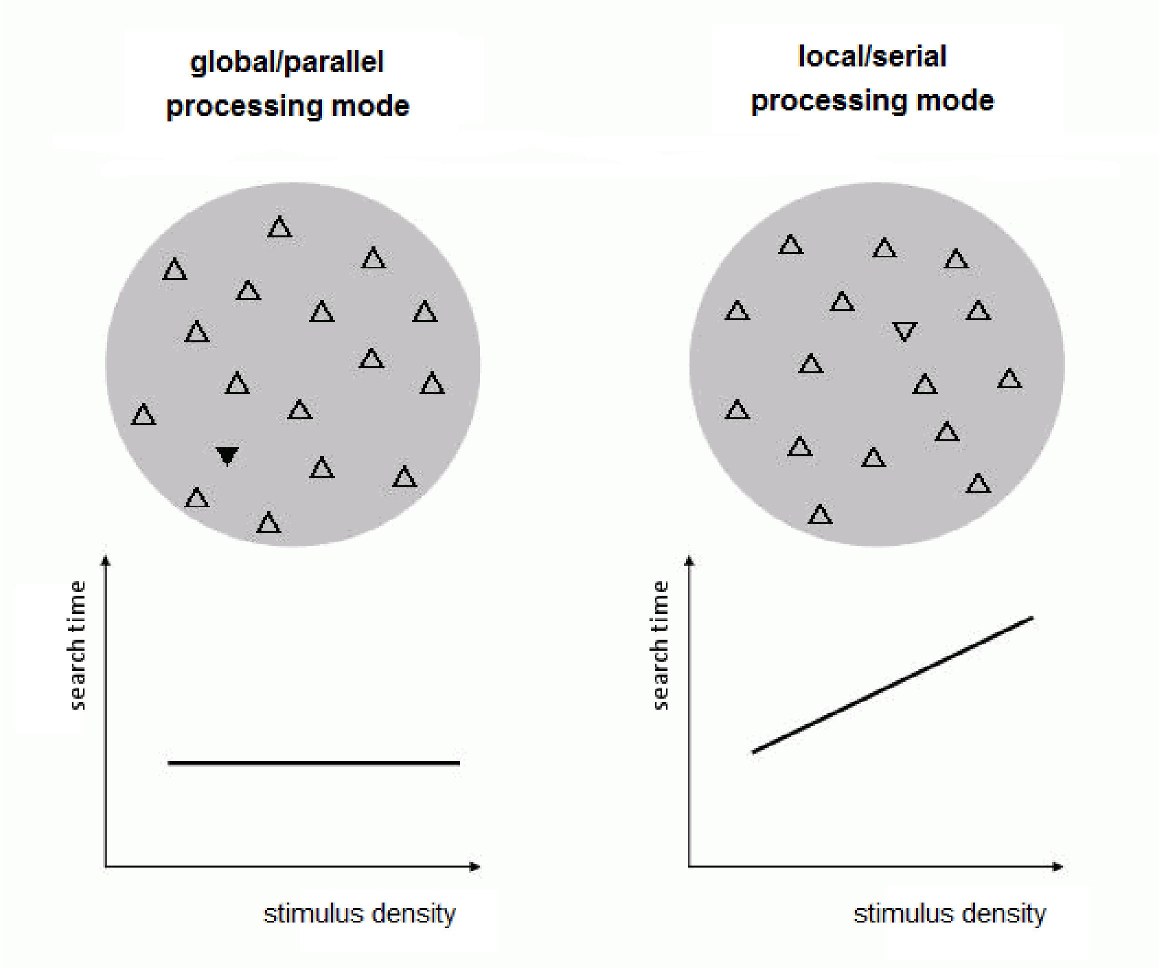

Fig. 2: search time progression for different search modes

An impairment of posterior parietal structures can lead to a contralateral (visual neglect) or bilateral (Balint syndrome) loss of the overview. But the impairment of these structures can also affect the simultaneous detection of a scene due to the loss of global visual processing mode. Without the simultaneous detection of a scene, a visual neglect or Balint syndrome exists (Zihl, 2003; Zihl & Hebel, 1997; Zihl & Nelles, 2004).

The narrowing of the attention field leads to a more significantly limited perceptual field and an insecure orientation within the scene, so that systematic scanning is aggravated. The results are (partially) omissions of parts of the scene and, much more often, the inability to process a scene using the global processing mode.

The scene is scanned area by area and non-systematically, which is noticed in visual

search tests as a very distinct "slowdown" in reaction times. The true cause for the significantly increased reaction time is the complex eye movement patterns that the patient uses to locate the target stimuli (Zihl, 2000).

Another very common cause for the loss of the overview are homonymous visual field deficits. In this case, the visual-sensory basis for the simultaneous holistic detection of the current environment is no longer given. The restriction of the overview is caused mainly by a narrowing of the attention field. Also, the complete processing and cognition of scenes, objects, faces, words, and numbers are hampered.

The uni- or bilateral limitation of the overview especially affects the reading capability if the holistic capturing of text material (words, numbers), which is essential for continuous and fluent text processing, is no longer possible due to the loss of parafoveal visual field areas (Zihl, 1995). Depending on the side of the parafoveal visual field loss, patients experience difficulties in finding the beginning or the end of the line or a word. The process of capturing and processing a text is then usually interrupted or even canceled. By adding (more or less successfully) words to a partially processed text, the patient usually tries to give the incomplete and partially incorrect processed text a meaning (Zihl & Nelles, 2004). Usually both the reading speed and the reading accuracy are reduced. Even more striking are the difficulties in processing the numbers, because a control or correction guided by the context is rarely possible here. The changes in information processing resulting from the narrowing of the attention field are also manifested in the eye movement patterns (Zihl & Hebel, 1997).

Homonymous visual field disorders are the most common type of cerebral visual field disorder, with approximately 75% of all cerebral visual disorder. About 60% of the affected people have a reduced overview and approximately 80% have an impaired reading performance - in most cases both are present. Because it cannot be expected that the visual field loss will spontaneously regress or that a patient will be able to spontaneously adapt to the vision loss, treatment to reduce the everyday disability is highly recommended. The acquisition of oculomotor compensatory strategies (replacement of the visual field by eye movement) has proven to be an efficient, ecologically valid and from cost perspective inexpensive method of treatment. Oculomotor compensatory strategies can be achieved by systematic training (Zihl, 2000; Zihl & Nelles, 2004).

Fig. 3 shows a reading excercise of patients with left-sided (LS) or right-sided (RS) parafoveal visual field loss. Note the various omissions and additions, with interruptions marked using three periods (…).

A headed echelon dispute among the animals developed, which of them was

probably the very best. To settle this worthless dispute, the horse said, we want to appoint the human to be the referee. The human is not affected at all by the echelon dispute and can therefore judge unbiased and impartial.

LS: A headed echelon dispute ... was among the animals, which of them was the best. To settle the worthy ... worthless dispute, the horse said, we want to ... appoint an human to be the judge. The human is not affected at all by the dispute ... echelon dispute and can therefore judge biased ... unbiased and impartial.

RS: A headed echelon ... echelon dispute among the animals developed, which of them is ... was probably the very best. To settle this worth ... worthless dispute ... we, the horse said, .. we want to appoint the human to be the referee ... as the referee. The human is not ... not affected at all ... by the echelon ... dispute and can therefore judge un ... biases ... without bias and impart ... ial.

Fig. 3: Reading extracts of patients with left-sided (LS) or right-sided (RS) parafoveal visual field loss.

Diagnostics

Homonymous visual field losses can only be determined validly by means of standardized perimetric procedures. Other means of testing only allow a rough estimate of the loss. The overview can be checked with the aid of so-called screening tests (e.g. cross-out tests, number-connection tests, trail marking tests), where, in addition to the search time, the search strategy (e.g. systematic or unsystematic sequence of the processed characters) should also be determined. For the determination of the reading performance, standardized reading tests with defined font size and defined length are suitable. For monitoring (e.g. comparison of before and after therapy), parallel forms are required. For the classification of the reading performance, age and educational background have to be considered as well.

For the appropriate usage of modules to capture the visual search and reading performance, the following exclusion criteria have to be heeded: insufficient visual acuity, reduced contrast vision, aphasia, pure/sheer alexia, visual neglect, insufficient attention and memory performance, double vision, disorders of convergence and accommodation. If an additional peripheral induced visual impairment (visual field, visual acuity, color vision) is suspected or in case of an insufficient optical correction, an ophthalmologic examination should be arranged (see Zihl, 2006).

1.1 Therapy

The main goals of the therapy are (re-)acquisition of a sufficient and rapid overview and a sufficient reading capability.

A specific approach is required because:

- the underlying coping processes are different, and
- different eye movement patterns have to be learned as a compensatory strategy.

The goal for the improvement of the overview is to simultaneously increase visual scanning speed when scanning templates and simultaneously improve or maintain high accuracy (preferably no omissions) even for complex scenes (e.g. when combining global and local processing).

The goal for the improvement of the reading capability is to increase reading speed and decrease reading errors.

For both functions, with an increasing difficulty of the task, an increasing approximation to real scenes or the real reading conditions occurs and thus efficient compensatory strategies are learned and established as routines. The primary objective for the training is to safely establish efficient oculomotor compensatory strategies for the overview, visual exploration, and reading. Transferring the newly learned routines to different conditions of everyday life in which different influential factors (e.g. tension, pressure to perform) come into play, has to take place in these situations.

A critical factor for the efficient acquisition of the described compensatory strategies is the approach that has to be taught to the patient. Basically the approach is to get a global overview before focusing on detailed local analysis. This should therefore display the basic objective of the training and become a secure routine during the course of the training phase.

For the **exploration training** this means that gaining a global overview should always precede the local analysis. The patient should first gain an overview as completely as possible before he/she scans a scene for details. This is done by means of large changes of sight that should be carried out systematically, e.g. by the largest possible eye movement to the left and then to the right, regardless of the side of the loss. In doing so, it is essential to make sure that the eye movement precedes the head movement, otherwise the eye movement will be insufficient for developing efficient compensatory strategies. The decisive factor is thus the direction of view and not the direction of the head.

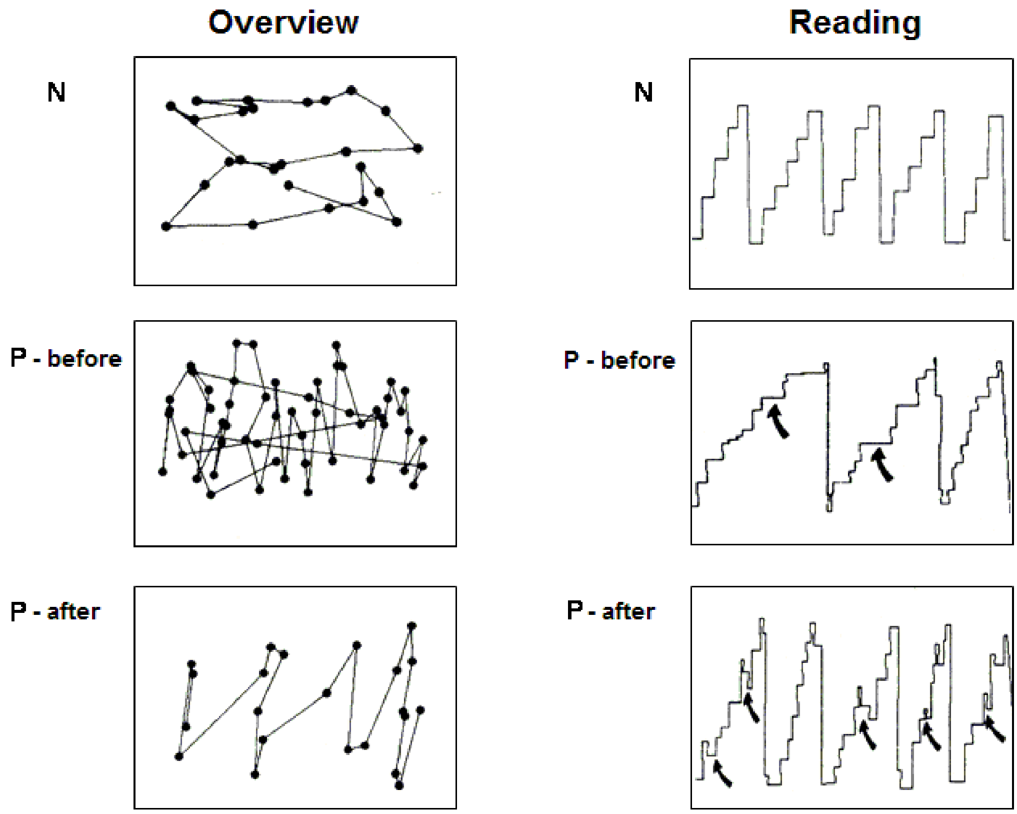

Fig. 4: Eye movements of a patient with hemianopsia

Figure 4 shows a side by side comparison of the eye movements for a healthy person and for a patient with hemianopsia who is going through exploration training and reading therapy. The eye movement pattern of the patient before (P-before) and after (P-after) the exploration training to improve the overview (left: scanning of a simple dot pattern), as well as before and after the reading practice (right: reading of a short text with 30 words in 5 lines) can be seen. The exploration training (visual search task) was started 7 weeks after the onset of the hemianopsia; the training frequency was about 9 sessions, 45 minutes each. The reading practice was realized after the exploration training - it included 16 sessions, 45 minutes each. Note the systematic scanning of the stimulus pattern and fewer points of fixation (dots) and saccades after the exploration training, as well as the "normalization" of the reading movement after the reading practice, especially regarding the fixation duration (longer duration illustrated by arrows in P-before). After the reading practice, numerous regressive saccades (illustrated by arrows in P-after) were found, meaning the patient's focus is led back to an already read word or word part.

- Search times in the exploration task: N: 7.4 s, P-before: 24.6 s, P-after: 11.2 s (no omissions before and after the training).
- Reading: N: 172 words per minute (wpm), P-before: 64 wpm, P-after: 137 wpm. The follow-up after 8 weeks showed similar results for the exploration task. The

reading capability was 156 wpm (the patient was asked to read regularly at home and to continue to practice the new reading strategy).

2 Description of the test

For the Visual Scanning screening module, the patient is supposed to detect a specific character (referred to as target stimulus) in a field of other characters (referred to as distractors) on the screen. In the test, the target stimulus is the letter "E," while the letter "F" is used for all distractors. If a target stimulus is present, the left arrow has to be pressed. If no target stimulus is present, the right arrow has to be pressed.

The screening module begins with instructions and a short exercise of 10 items, helping the patient understand what to do. The exercise can be repeated if needed.

After the exercise, the screening module continues with the test, which consists of 10 tasks with 20 items each. The tasks are divided into two sets: the first 5 tasks use parallel search mode, the last ones use serial search mode.

Before every item, an interstimulus interval consisting of a black screen with a blue cross is shown for a short time (see Fig. 5). The patient shall focus on the cross during the interval.

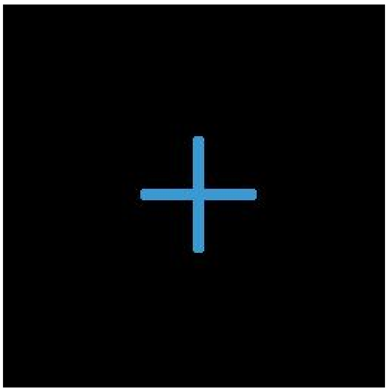

Fig. 5: Interstimulus interval

After the interval, the item’s stimuli are displayed on the screen. For each set of tasks in the test, the number of distractors increases. (see Fig. 6)

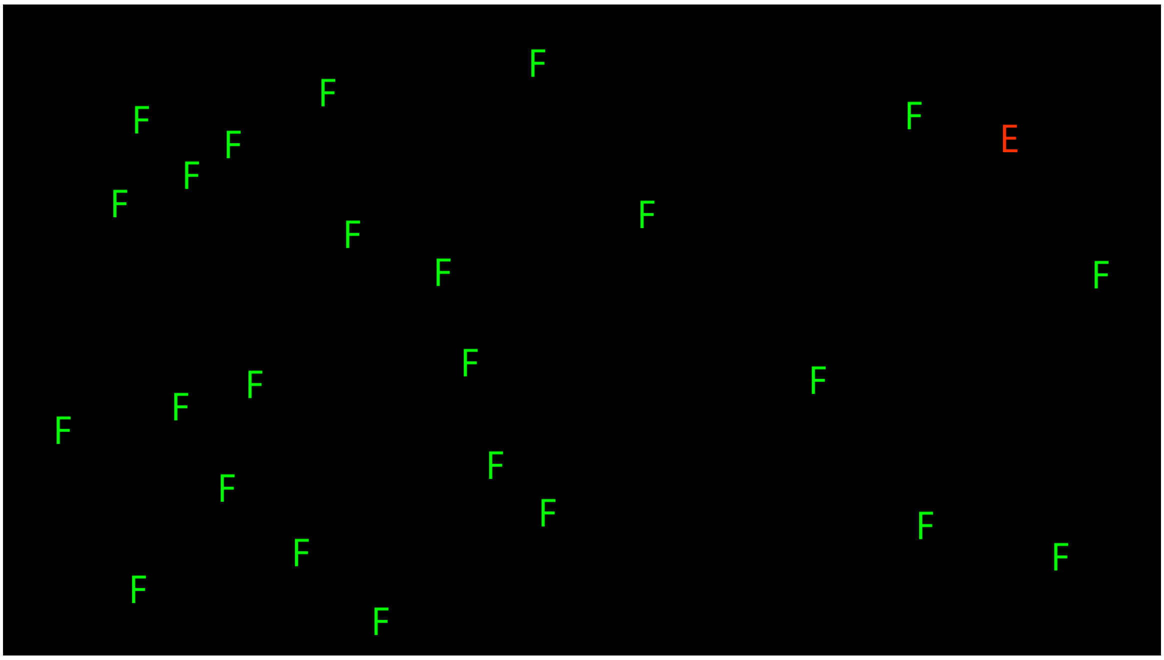

Fig. 6: Task 5 using parallel stimulus mode with "E" as target and "F" as distractors

The following events are considered a mistake:

- when the left arrow key is pressed even though no target stimulus was present (false positive reaction)
- when the right arrow key is pressed even though a target stimulus was present (false negative reaction)
- when there is no reaction to an item (omission)

2.1 Instruction

The actual implementation is preceded by an exercise task. The exercise task consists of 10 items. Each item presents a single stimulus, either the target ("E") or a distractor ("F").

In the exercise, the patient is supported to look for the character "E" on the screen and respond appropriately by pressing either the left or right arrow key (see Fig. 7). For the exercise the reaction time of the patient is not relevant.

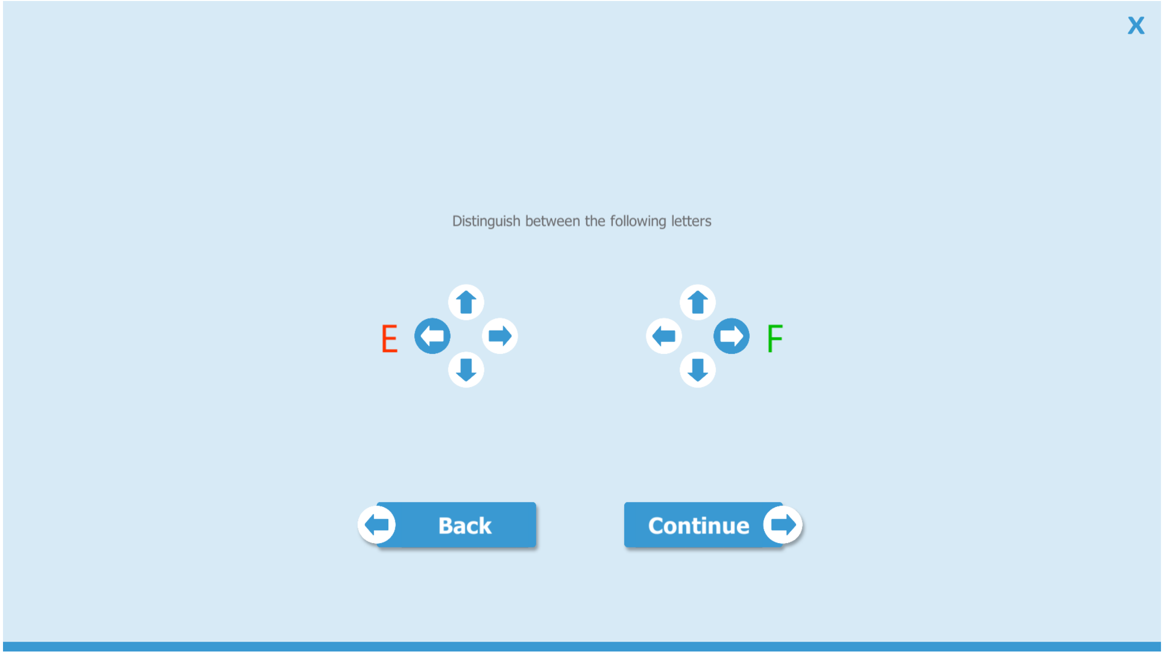

Fig. 7: Instruction pre-test

If the patient presses the incorrect arrow key during the exercise, he will receive a visual feedback (see Fig. 11).

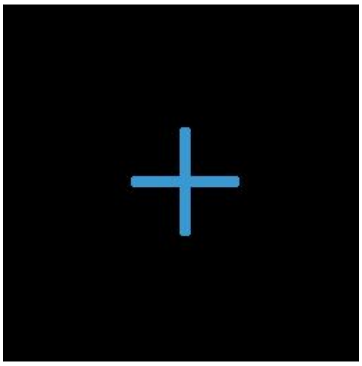

Fig. 8: Interstimulus interval

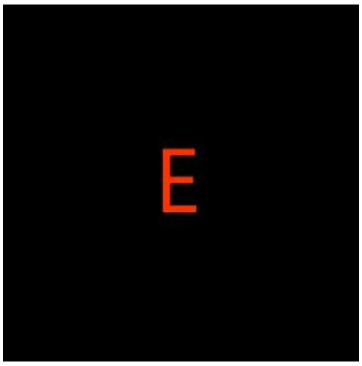

Fig. 9: Target stimulus

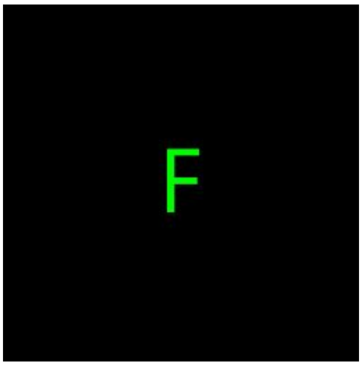

Fig. 10: Distractor

Fig. 11: Feedback after wrong reaction during the exercise

After finishing the exercise, the patient has the option to repeat it. Else the test will start. During the test, there are no messages when the patient responds to an item incorrectly.

2.2 Additional data/instructions

Visual search with "E" and "F"

If the patient needs additional instructions on what to do, you can read him/her this text:

First, you will see a blue cross in the center of the screen. Immediately after the blue cross has disappeared, the letters "F" and "E" appear. Please search for the "E". If you have found the "E", press the left arrow button. If no "E" is present, press the right arrow button. It is very important that you scan the screen as accurately and as quickly as possible. Accuracy is most important. You are not supposed to overlook an "E", but still search very quickly. Always start first by scanning the screen with large eye movements from left to right so that you get a complete overview.

Please note carefully: For the success of the training, it is crucial that patients first get a complete overview by using large eye movements before searching locally. For parallel search mode, this overview is usually sufficient enough to decide whether the target stimulus is present. For the 'mixed' or the serial search mode, however, the patient must also search "locally" in the second step. Nevertheless, it should be stressed that, even when choosing the local search mode, gaining a complete overview is the first step of the visual search.

2.3 Testing

Implementation and duration of the test

After the exercise was completed successfully, the test starts. The test begins with the set of tasks that require only the parallel search mode. The tasks in each set increase in difficulty by increasing the stimulus density used in an item (see Tab. 1). The ease with which target and distractor stimuli can be differentiated decreases from the parallel to the serial search mode. Each stimulus mode consists of five tasks with an increasing density.

Task	Number items	Stimulus mode	Stimulus density	Target	Distractor
1	20	parallel	1	E (red)	F (green)
2	20	parallel	5	E (red)	F (green)
3	20	parallel	9	E (red)	F (green)
4	20	parallel	17	E (red)	F (green)
5	20	parallel	25	E (red)	F (green)
6	20	serial	1	E (green)	F (green)

7	20	serial	5	E (green)	F (green)
8	20	serial	9	E (green)	F (green)
9	20	serial	17	E (green)	F (green)
10	20	serial	25	E (green)	F (green)

Tab. 1: Levels of test difficulty

Each item is limited with a maximum reaction time (see Tab. 2). The maximum reaction time was calculated from the standard values and corresponds to three standard deviations from the average value of the norm sample, meaning a value <= T-norm 20. A distinction is made in the reaction times between the age groups < 40 years and >= 40 years.

	max. reaction time (ms) target item			
	patient's age < 40 years		**patient's age >= 40 years**	
Task	**target stimuli**	**distractors**	**target stimuli**	**distractors**
1	930	1060	1060	1190
2	1050	1110	1190	1220
3	1080	1190	1260	1300
4	1090	1410	1310	1530
5	1110	1640	1350	1790
6	940	1130	1090	1240
7	1560	1770	1740	1840
8	2290	2800	2400	2950
9	2670	3960	2820	4260
10	2820	6720	2980	7560

Tab. 2: Maximum reaction times for the test

The test takes about 12 minutes.

2.4 Data analysis

Basic information on the data analysis of screening results is available in the RehaCom manual, chapter "Screening results".

Overall view standard values

In the Visual Scanning screening module, two performance values are calculated and presented as T-norm, Z-norm and percentile rank on the basis of a norm sample (see Fig. 12).

parallel search: Average value of the median reaction times for tasks 2–5, only considering correct reactions in target runs

serial search: Average value of the median reaction times for tasks 7–10, only considering correct reactions in target runs

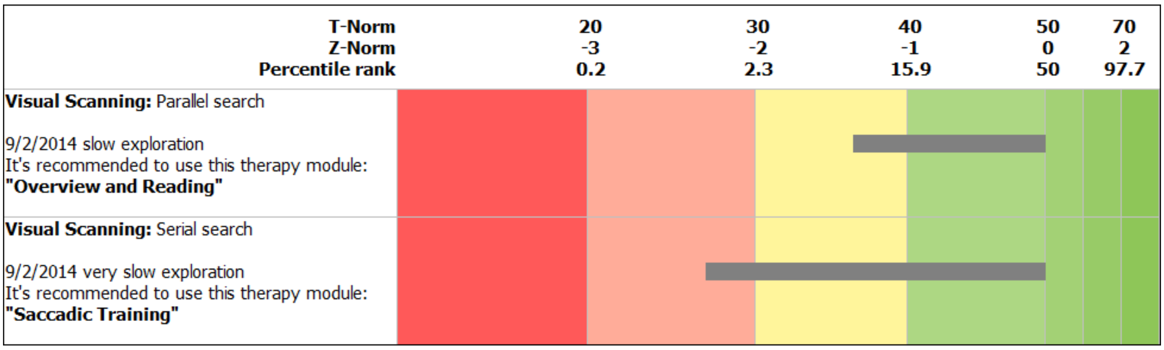

Fig. 12: Complete overview of Visual Scanning, parallel and serial search

T-norms greater than 60 indicate an above average performance, T-norms lower than 40 indicate a below average performance.

Details

The detailed view can be accessed by double clicking on the colored areas of the Visual Screening overall view. You can also select the Visual Scanning screening module in the list of the Results window in the Screening tab, and then click on the Details button on the right.

Result Table: Overall performance target runs

The results table contains detailed information on every task (see Fig. 13).

Test Patient B-Day.: 10/13/1959 Date: 7/15/2016

HASOMED RehaCom Visual Scanning

Task no.	stimuli density	Mode	Correct	Mistakes	Omissions	Median Reac. Time Correct [ms]	Median Reac. Time Mistakes [ms]	Median Reac. Time w/ target items [ms]
1	1	parallel	9 (45%)	1 (5%)	10 (50%)	921	904	1060
2	5	parallel	10 (50%)	2 (10%)	8 (40%)	1029	1170	1155
3	9	parallel	12 (60%)	0 (0%)	8 (40%)	1146	0	1170
4	17	parallel	18 (90%)	0 (0%)	2 (10%)	1130	0	1138
5	25	parallel	17 (85%)	1 (5%)	2 (10%)	1201	1341	1186
6	1	serial	0 (0%)	18 (90%)	2 (10%)	0	866	874
7	5	serial	17 (85%)	0 (0%)	3 (15%)	1357	0	1357
8	9	serial	17 (85%)	3 (15%)	0 (0%)	1436	1934	1404
9	17	serial	17 (85%)	3 (15%)	0 (0%)	1997	2246	2075
10	25	serial	12 (60%)	8 (40%)	0 (0%)	2348	2184	2293

Fig. 13: Result details for each task

In the results table, the median of the reaction times for correct reactions to target stimuli as well as the incorrect reactions for all tasks are displayed.

Explanation of columns in the results table

Task no.	serial number (see Testing)
Stimuli density	number of stimuli (letters) on screen
Mode	parallel or serial mode
Correct [%]	number and percentage of correct responses (correct response based on whether the target stimulus is among the stimuli or not)
Mistakes [%]	number and percentage of incorrect responses (incorrect response based on whether the target stimulus is among the stimuli or not)
Omissions	no reaction or reaction was too slow (no reaction within max. reaction time)
Median RT Correct [ms]	median reaction times for correct responses
Median RT Mistakes [ms]	median reaction times for incorrect responses
Median RT Target Runs [ms]	median reaction times for correct responses when the target stimulus is present

Bar chart: course reactions

Fig. 14 contains the number of correct reactions and the omissions for each task.

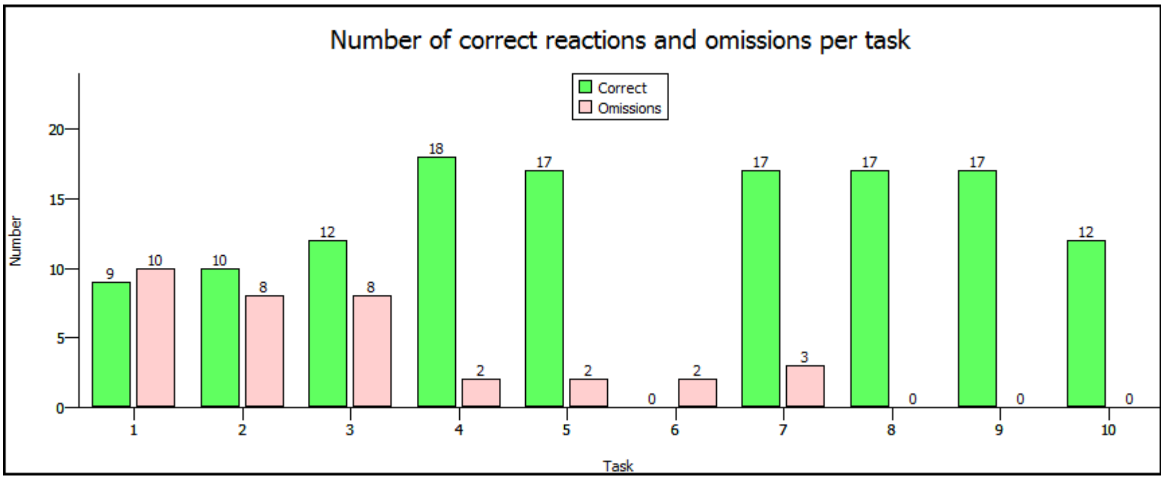

Fig. 14: Side-by-side comparison of correct reactions and omissions per task

In Fig. 14, the median reaction times for the correct and incorrect reactions in each task are displayed.

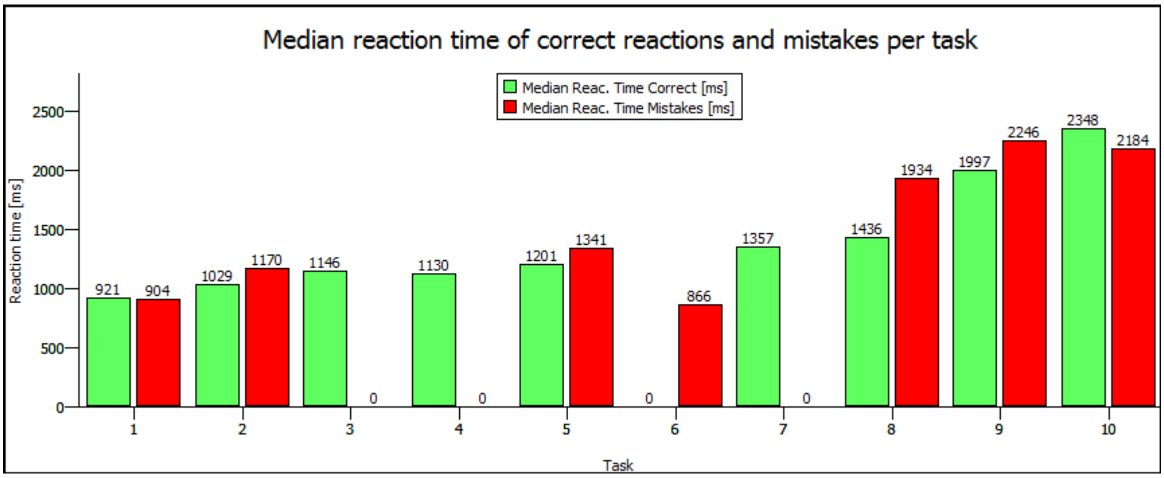

Fig. 15: Side-by-side comparison of median reaction times for correct reactions and for mistakes per task

The data for all items with a target stimulus is provided for each quadrant of the screen (see Fig. 16). The data is further divided between the parallel and serial stimulus mode.

Parallel items (tasks 1–5)		Serial items (tasks 6–10)	
Quadrant: 1 Correct: 1 (8%) Mistakes: 11 (85%) Omissions: 1 (8%) Average of the medians: 665 ms	Quadrant: 2 Correct: 0 (0%) Mistakes: 12 (86%) Omissions: 2 (14%) Average of the medians: --	Quadrant: 1 Correct: 1 (8%) Mistakes: 11 (85%) Omissions: 1 (8%) Average of the medians: 1638 ms	Quadrant: 2 Correct: 2 (14%) Mistakes: 11 (79%) Omissions: 1 (7%) Average of the medians:
Quadrant: 3 Correct: 1 (7%) Mistakes: 12 (86%) Omissions: 1 (7%) Average of the medians: 717 ms	Quadrant: 4 Correct: 2 (14%) Mistakes: 12 (86%) Omissions: 2 (14%) Average of the medians: 608 ms	Quadrant: 3 Correct: 4 (29%) Mistakes: 9 (64%) Omissions: 1 (7%) Average of the medians: 1641 ms	Quadrant: 4 Correct: 9 (64%) Mistakes: 5 (36%) Omissions: 0 (0%) Average of the medians: 1198 ms

Fig. 16: Data displayed in quadrants

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