

HASOMED RehaCom[®]

Cognitive therapy



**Screening:
Visual Field**



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).



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.

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1 Disorders of the visual field

Basic information on the data analysis of screening results is available in the RehaCom manual, Chapter "Use of RehaCom screening modules".

Impairments of vision, visual-spatial perception, and attention are common results of brain injuries. According to Zihl (2006), 20–40% of patients with an acquired brain injury have visual problems, 61.7% of those patients have restrictions or losses in the visual field.

The ability to see is a very important sensory function. Disorders affecting the visual field impact orientation and, depending on the degree of disturbance, have an effect on everyday actions (e.g. searching and finding objects when eating or getting dressed, safely navigating a room without bumping into something, recognizing faces, reading the newspaper, watching TV, using the computer). Visual field is vitally important, especially when driving a motor vehicle. Disorders of the field of view and visual field affect participation in many aspects of life according to ICF and therefore require therapy and rehabilitation to improve the participation.

Body-Head-Eye system

A persons entire body is actively involved in the visual orientation and visual cognition, including the orientation and position of the body, the head, and the eyes in space; the performance capability of the eyes (e.g. visual acuity or agility), and eventually the central information processing of all involved sensomotoric processes in the brain. Our normal behavior is that we constantly move our body or very rarely remain motionless. We constantly explore objects and our surrounding world with countless eye movements geared to our current goal of action, or briefly turn to peripheral new stimuli and assess them. The field of vision solely by eye movements (without moving one's head) is thereby smaller (about 50° one-sided) than the peripheral visual field in central fixation (about 90° one-sided). The combination of the field of vision and the visual field extends the visual range up to 115° (one-sided). The field of vision can be shifted sideways even further by head and body movements.



Fig. 1: Full visual field of both eyes

Shape recognition is quite possible in the central field of vision (about 5° on one side unilateral) with fixation; in the peripheral visual field without fixation, even color perception (see fig. 1) and especially motion perception are possible. In order to reliably recognize and differentiate shapes and patterns, focusing on the stimulus visually (fixation) is necessary.

Figure 2 shows the qualitative visual field limits in the normal left visual field.

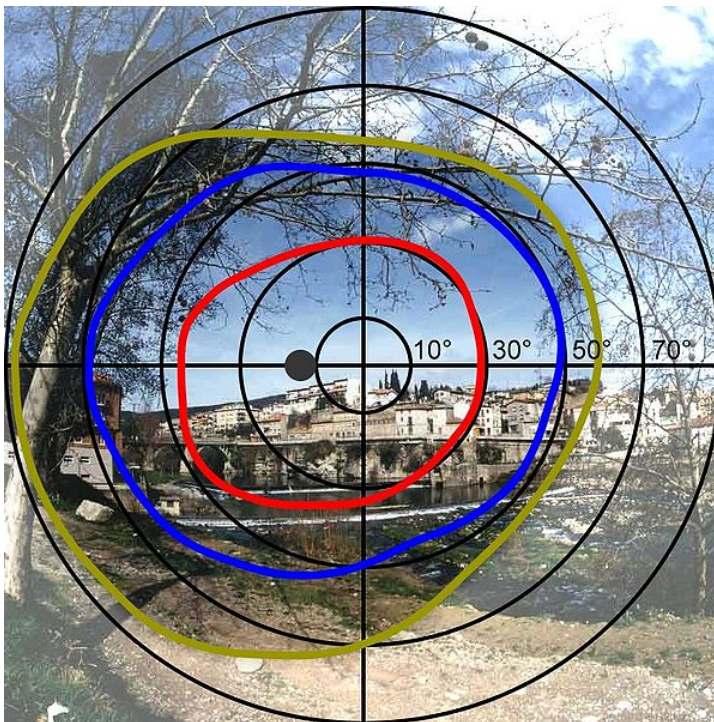


Fig. 2: qualitative visual field limits in the normal left visual field

Fig. 2 shows a polar diagram of visual field of the left eye [Wikipedia].

red and blue circles: sensitive area for colors;
yellow circle: entire visual field; black spot: blind spot

Consideration of further cognitive performances

The ability to see is an integral part of our interactions with the world around us. Because the ability to see is so important, further cognitive performances, especially attention, are always involved.

When testing a patient's visual field after an acquired brain injury, you should also take into account other performance functions, such as attention and concentration, memory and executive functions. The interpretation of results depends on many factors, particularly in the early phase after a brain injury (1-4 months), where a characteristic instability for many functions will be found.

You should make sure to have pauses during the implementation of therapy. Also ensure the comprehension of the instructions by repetition (in case of memory losses) (Zihl & von Cramon, 1985).

Triad of the limitations of the visual field

In disorders of the visual field and the visual perception, there are three limitations (Zihl & von Cramon, 1985) for which we may collect measurements:

- limitations of the visual field that affect stimulus detection at a central fixation (visual field limitation)
- limitations of spontaneous amplitudes and systematics of eye movements in the affected visual field (narrowing of the field of vision)
- limitations of spontaneous exploratory searching and noticing of stimuli (spatial attention restriction)

Limitations of the visual field and saccadic movements / gaze strategies can occur, especially in a patient with homonymous hemianopsia without disorders of the attention field.

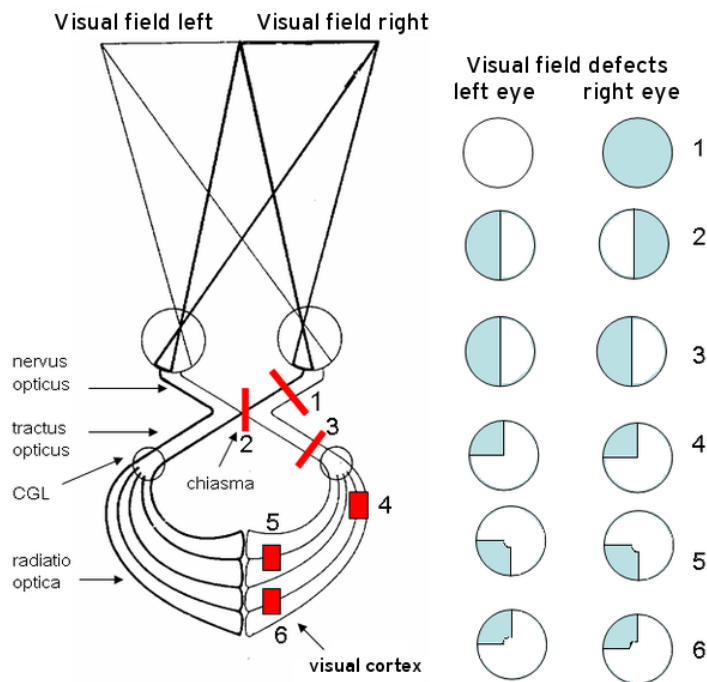


Fig. 3: Visual field deficits depending on the location of the lesion

- o 3) homonymous hemianopsia (right or left): In both eyes, the same side is affected by loss (patients see only the left or right side of an image section - occurs frequently)
- o 2) heteronymous (binasal oder bitemporal) hemianopsia: On both eyes the opposite side is affected by loss (patients suffer from "tunnel vision" - occurs rarely)
- o 4 - 6) Quadrantanopsia is characterized by the loss of a quarter of the visual field. Like the hemianopsia the quadrantanopsia is mostly homonymous, both eyes are affected by the loss in the same quadrant.



Fig. 4 : Restricted visual field in hemianopsia to the left

Disorders of the visual-spatial attention (neglect)

In case of severe neglect, the three limitations must be considered. Neglect phenomena can be assumed if spontaneous orientation, stimulus discovery, and exploration by saccades are disturbed. The patient might not detect people, items, or test stimuli in the affected part of the visual field (Heilmann, 1979; Karnath, 2003).



Fig. 5: Restricted field of perception in neglect to the left

In patients with neglect, indicators for neglect can often be found in other sensory modalities, such as extinction at double simultaneous stimulation, visual-spatial disorders, and improvements in performance on conscious attention allocation.

Patients with hemianopsia without neglect can't improve visual field deficits by conscious attention allocation (Kerkhoff, 2004).

Therefore, a competent differential diagnosis is important, especially as lesions are not uncommon where hemianopic vision deficits and neglect phenomena can be found in the acute phase and can only be differentiated in the chronic phase (> 3 months after lesion).

Through spontaneous remissions in the acute phase, neglect disorders can almost halve to about persistent 33% of patients with right hemispheric lesions and approximately 13% of patients with left hemispheric lesions (Stone et.al., 1991, as cited by Kerkhoff, 2004). In the clinical practice, it is not uncommon for patients to show a quadrantanopsia that was previously hidden by the neglect.

In the event that you suspect a patient having a disorder combined with neglect and hemianopsia/quadrantanopsia, both defects should be treated.

1.1 PC-supported detection of visual field deficits

The ophthalmologists use perimetry to measure the visual field by varying either position or intensity of a stimulus (e.g. Goldmann perimeter or Tübinger perimeter). Under standardized stimulus conditions, the ophthalmologist can examine both the expansion of the general visual field (stimulus detection) and, if required, the limitations for the light sensitivity, color, and shape recognition accurately.

In the neurological clinic, rehab clinic, or outpatient neuropsychological practice, cost-intensive perimetry is (usually) not available. It is therefore necessary to resort to simple testing, using paper-pencil methods and PC-based visual field screenings. However, this diagnostic instrument allows an imaging of visual field deficits, neglect symptoms and reading disorders that is sufficiently precise for therapeutic indications.

In the PC-supported measurement of the visual field, which is used as a screening, limitations towards a perimeter are existing in the methods that were available up to now:

- as a result of the limitation of the monitor, the covered visual angle area is much smaller
- the programs do not allow an evaluation of the contrast sensitivity, color or shape perception
- the fixation constancy can not be observed in confrontation

By the use of modern flatscreen monitors (24" or 27") or TV (32" or 34"), PC-supported coverages are already able to capture a binocular visual field up to 30°. When using a projector with a rear projection screen, the coverage can be expanded up to 60° (that corresponds to the required visual field for the driving ability).

Central and peripheral task

In the perimetry, the fixation constancy is controlled by a person who observes the patient from the front and reacts accordingly when leaving the fixation. This possibility is missing when measuring the visual field on the PC. Besides the frequency of measured points, the fixation constancy as a critical indicator of a precise measurement is of particular importance.

To control the fixation constancy, a central task was therefore introduced into PC visual field tests, which can only be solved by visual focusing. In parallel, the actual measurement of the perception of stimuli in the visual field was defined as a peripheral task. This created a dual task design with requirements on increased attentional performances. In addition to the sustained attention, the selective and divided attention performances mainly belong to it.

For example, the original version of a common PC visual field testing consists of a

visual-verbal central task (recognize letters and name them verbally) and a visual discovery task of peripheral kind (notice flicker stimuli and press the button). The transition between the central and the peripheral task requires adaption ability and sequencing (verbal naming, nonverbal keystrokes). The stimuli are presented for a maximum of 3000 ms. The presentation time is also the maximum reaction time.

The peripheral stimulus is displayed over a "longer" period (max. 3000 ms) and can cause an automatic orienting response, an eye movement up to the Flicker stimulus. The shortest trial version runs for about five minutes, the longer version more than ten minutes without pause.

In the new variant, the central task has been replaced by a nonverbal visual discrimination task with requirements on selective attention (answer 4 target stimuli out of 8 stimuli). The response reaction in the central task is nonverbal in the form of a keystroke and has been aligned to the output of the peripheral task. The presentation time of the central stimuli is 400 ms. The presentation time of the peripheral stimuli is 3000 ms. The test duration is five minutes without a pause.

Another newer screening design for driving ability diagnostics combines the measurement of the visual field with distractor stimuli, which are used in neglect examinations. The screen is filled with grey dots. One dot at a time can flash up brightly (peripheral task). The presentation time for peripheral stimuli was shortened to 800 ms. The central task again consists of a nonverbal visual discrimination task with requirements on selective attention (answer 4 target stimuli out of 8 stimuli). It has to be reacted to both tasks non-verbally with a keystroke. The number of central stimuli and thus the requirements on the visual focusing was significantly increased (ratio stimuli central / peripheral: 470/85).

Requirements on selective and divided attention

Attentional processes and requirements for greater attention performance outside the spatial attention are involved in all previous designs for PC-based visual field tests and may affect the actual intended visual stimulus perception and response action in disorders of attention performance.

To reduce the impact of attention deficits, the discrimination tasks should be as simple as possible (selective attention).

The central and peripheral task should be of the type and modality as similar as possible in dual-task design to keep the demands on the shared attention low.

To relieve the focused attention and sustained attention, pauses during the implementation should be made possible.

Visual field tests enable conclusions about the patient's performance and a probability indication of the available field of view, but they are not a direct measurement of the underlying cerebral failure or neuronal damage.

Directly observable and computerizedly measurable are only behavioral responses to the stimuli of the task. An omission or incorrect reaction may also have other causes than immediate vision loss. The interpretation of the overall result therefore

requires professional expertise.

Other situational conditions such as daytime and lighting conditions, psychological state or medication can have an effect on the result. Therefore, care should be taken to standardize the examination situation (e.g. darkened room).

2 Task description

The Visual Field screening is a PC-based test primarily for monitoring and evaluating visual field deficits. The test measures visual field boundaries and provides information on the severity of the visual field deficit. For the most comprehensive evaluation of a patient's visual field, additional data should also be collected regarding potential visual neglect.

The Visual Field screening module uses a dual-task design, in which the central task and the peripheral task are similar (discover a circle and respond non-verbally by pressing a key).

Central task

The central task is to maintain attention on the circle in the middle of the screen. This is tested by the intermittent appearance of a smaller brighter circle within a larger darker circle (see figure 6). This central task amounts to 40% of the number of stimuli presented in the screening.

The contrast between the inner and outer circle is done in such a way that a patient will be able to perceive the appearance of the inner brighter circle only within a range of 5° laterally while focusing on the center circle.

When looking into the periphery, the patient loses the ability to discriminate the differences inside the center circle. Slightly subdued light and normal contrast sensitivity is desired to discriminate the inner circle (this can be checked in the exercise).

The presentation time of the central stimulus is short by default (200 ms).

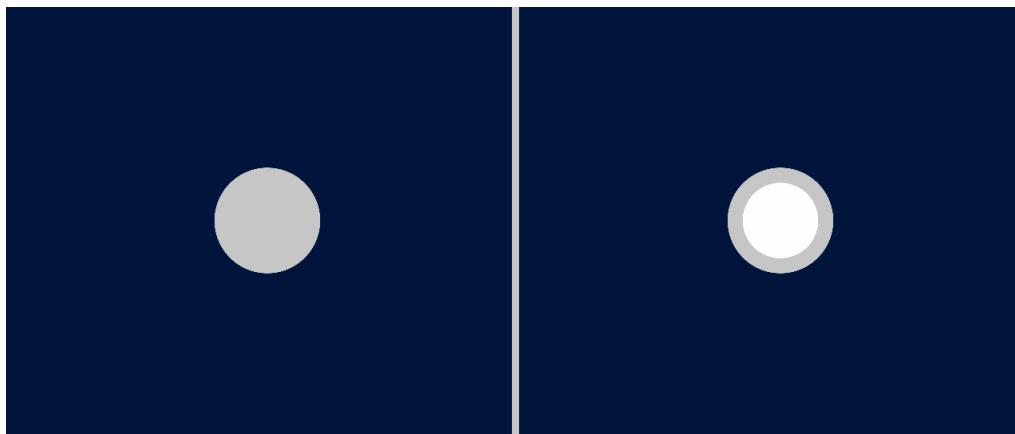


Fig. 6: central task (left: fixpoint standard view ; right: reaction required)

Peripheral task

The concept of the peripheral task is a choice reaction task with demands on selective attention. The relevant stimulus is a line radiating from the center with a circle at the end.

The irrelevant stimulus also is a line radiating from the center, but without a circle at the end (see fig. 7). When the irrelevant stimulus is presented, the patient must not press OK, which creates a kind of Go / No-Go task. A keystroke following an irrelevant stimulus is considered as an error. No response to the relevant stimulus will be considered as an omission.

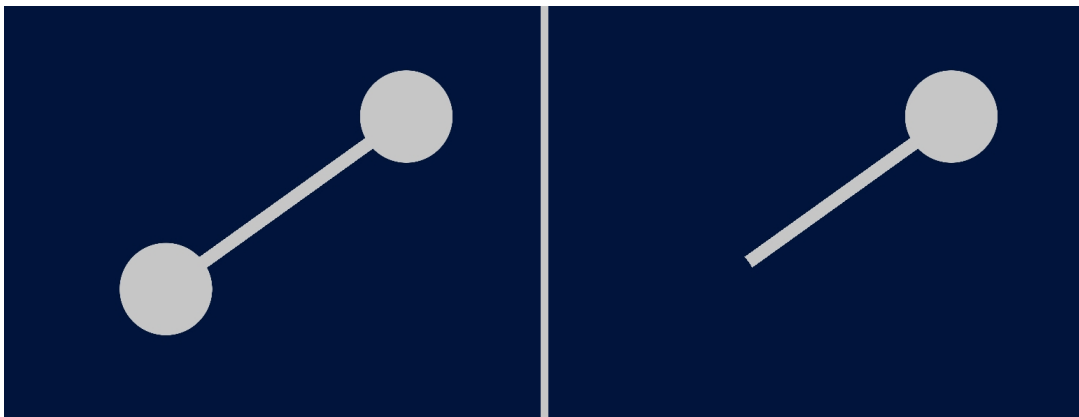


Fig. 7: peripheral stimulus (left: relevant; right: irrelevant)

In the peripheral task, both stimuli are presented only for a very short time (200 ms). For the patient's response, however, a significantly longer maximum response time is available (2000 ms). Some other visual field screenings use the same amount of time for presentation and reaction. For the RehaCom Visual Field screening module, time for presentation and reaction are decoupled.

The reaction time begins with the short stimulus presentation time, and continues beyond the stimulus presentation. This allows a maximum response time, longer than the appearance of the stimulus in the visual field. Even slower patients can adapt. Because the stimulus appears for a very short time, the patient does not have time to orient his or her focus toward the stimulus location with saccadic eye movement.

Examination of the sites of stimuli

The four quadrants contain 12 stimulus locations each (48 in total). At each stimulus location 2 relevant stimuli and 1 irrelevant stimulus are shown.

For each stimulus 3 responses are possible:

1) correct, 2) omission, 3) error.

The patient's responses to the two relevant stimuli at each location are crucial to the

interpretation of the patient's perception within the visual field. The results show three evaluation patterns:

- 1) RR: 2x reacted correctly (100%): optimal perception at the site of stimulation with high probability
- 2) RA: 1x reacted correctly (50%), 1 omission: insecure perception at the site of stimulation
- 3) AA: 2 omissions (0 %): perception deficit at the site of stimulation with high probability

Because a correct result to irrelevant stimuli is deduced from not responding, the patient's reactions to the irrelevant stimuli are not used to evaluate the visual field.

The same applies to errors of "uncertainty" whether the presented stimulus was relevant or not. Better interpretable are selective errors based on unsuccessful inhibition of reaction, when they occur inside the not affected half of the visual field. The distribution of errors in the halves / quadrants - systematic or random - provides good evidence for interpretation.

The behavior of the patient during testing provides another source for interpretation: the patient will usually acknowledge reactions to irrelevant stimuli by hasty, uninhibited reactions like uttering a sound or a body movement. Reactions like this to errors inside the affected field are absent.

The major performance parameters for the assessment of the visual field are:

- Correct reaction within the maximum reaction time,
- Omission when exceeding the maximum reaction time,
- Reaction time median of correct reaction (ms).

Interpretation of performance quality

For the assessment of the quality of the screening measurement, other parameters have to be interpreted:

- % of fixation accuracy (reactions to the central stimulus)
- Errors (missing inhibition on irrelevant stimuli - distribution across the hemifields)
- Distribution of the omissions and errors in each phase (the testing intervals between the pauses)
- Reaction time (in ms) for each of the relevant stimuli

Maximum reaction time and interstimulus interval (ISI)

The maximum reaction time for the central task is by default 2500 ms, for the peripheral task 2000 ms. The latter can be extended to 2500 ms by using the "extended processing time"-mode. If there is a reaction, for example, at 600 ms, the item is completed and then followed by an interstimulus interval before the next item is presented.

The interstimulus interval (ISI) has a uniform stochastic distribution ($\pm 50\%$) and is not predictable. At an ISI of 1700 ms, the actual interval can range from 850 ms to 2550 ms. At an ISI of 2500 ms, the actual interval can range from 1250 ms to 3750 ms.

2.1 Parameter settings

The screening begins with a start screen.

The screenshot shows a 'Visual Field' configuration window with the following settings:

Parameter	Value	Unit
Visual field deficit	right	
Testing	both eyes	
Screen width	530	mm
Screen height	300	mm
Distance eye screen (centre)	600	mm

Additional options on the right:

- extended processing time: ☐
- increased fixation control: ☐
- additional exercises: ☐
- Change parameters:

A note at the bottom states: 'The optimal distance to the screen is 673 mm.'

At the bottom are two buttons: 'Reset' (with a circular arrow icon) and 'Apply' (with a checkmark icon).

Fig. 8: start window (with adjustments for 24" screen)

Size of the screen / Distance eye - screen

Settings in the start window (fig. 8)

Before using the screening, the screen size (visible area) has to be set. From this data, the screening calculates the magnitude of the measured field of view in angular

degrees. The results are shown in [data analysis](#). If the screening was finished, the data will be saved and restored in the next run.

Since 2013, many new PC monitors have 24 to 27 inches, and 32" LCD TVs are available at an affordable price. The common distance of the eye from monitors of this size is 50–60 cm (20–25 inches), a field of view is measured at about 20°.

This is sufficient for the measurement of the central visual field or the field of activity in everyday life (e.g. eating at the table, reading the newspaper).

For the measurement of the peripheral field of view in a range up to 60° (for example, to diagnose driving abilities), larger display screens are necessary. A projector with a translucent screen in a 20 square-meter (200 square-feet) room may help. For this reason we recommend administering the Visual Field screening module using a projector when more of the peripheral visual field needs to be measured.

When using a monitor or display of different size, the size of the stimuli can be redefined in the [parameters](#) (see Table 1 below). Furthermore, the parameter setup has to be adapted to the type of display used, especially the brightness of background and stimulus. TVs and projectors have different light intensities - projectors usually have lower brightness and contrast.

To keep the distance of the eye to the monitor constant during testing, a chin rest can be used. The by the chin rest fixed posture can also be a distracting stressor, especially when having physical hemiplegic symptoms and problems while keeping a constant sitting position. The use of the chin rest should be comfortable for the patient and not lead to an additional stressor. Without the chin rest, the test is somewhat less accurate, but the less accurate results can be tolerated because the recommended training modules are also accomplished without a chin rest.

Extended processing time

Checkbox in the main menu (fig. 8)

During instruction, the behavior of the patient can be monitored. When the patient responds slowly or needs more recovery time between reaction to a stimulus and the presentation of a new stimulus, the screening can be aborted by pressing ESC and started again afterwards. A longer processing time can be set (checked). If you suspect delayed reactions before starting the test, "extended processing time" should be checked right from the beginning.

With extended processing time selected, the stimuli follow at longer intervals. The patient is given more time to react to presented stimuli, furthermore, the time before the next stimulus is presented is increased. Because the patient is given more time, the test is less stressful.

With the total duration of the test extended, patients who experience a mental or physical slowness will be better able to complete the test without frustration.

Increased fixation control

Checkbox in the main menu (fig. 8)

The increased fixation control can be added for highly inattentive patients who spontaneously lose focus on tasks and start to look around, make saccades to the stimulus, or repeatedly turn their view to the test administrator.

In this case, the frequency of the central stimuli is changed (from 40% to 60%) to increase the measurement quality and fixation accuracy. At 60%, fixation stimuli are more likely to keep the patient's attention.

The test then is a bit longer, but the greater validity of the result justifies the appropriate extension.

Additional exercises

Checkbox in the main menu (fig. 8)

Normally, the task of the screening will be practiced within an exercise. If this is insufficient for the patient, the learning curve can be expanded by checking the "Additional exercises"-box. This will add to more exercises to the screening. In the first one, only the reaction to central stimuli is practiced. The second one exercises the peripheral task. When both exercises are finished, both tasks will be practiced at once.

Change parameters

Button in the main menu (fig. 8)

By setting additional [parameters](#) the system can be adjusted to fit different display types, account for various measurement environments, and minimize behavior that could affect the test.

Start test left / right

Buttons in the main menu (fig. 8)

The test is usually performed with patients who are believed to have a visual field impairment (hemianopsia or neglect) based on results from another test (e.g. paper-pencil neglect diagnostic, confrontation tests such as finger perimetry, or reading trial). In severe neglect, the observation of behavior in everyday life would provide sufficient evidence.

If the affected side of the visual field is known before the test starts, the instruction texts and exercise stimuli can be presented in the unaffected (or less affected) side.

2.1.1 Extended paramters

The brightness and contrast of the central task can be controlled and adjusted for various displays (e.g. PC, TV, projection screen). The goal is to set up the central stimulus in a way that the change of brightness can't be perceived beyond a 5° deviation from the center point. The difference in brightness between the values for the larger darker circle and the inner lighter circle amounts to 22% by default, which is easily perceptible if the room is darkened slightly (no sunlight falls on the display) and if the patient has no loss of contrast sensitivity. The default values for peripheral and central stimuli are 100%/78% with a background brightness of 12%.

Visual Field

timewise parameters		visual parameters	
Stimulus duration	200 ms	Amount fixation controls	40 %
maximum reaction time	2000 ms	Amount fixation controls increased	60 %
maximum reaction time (extended)	2500 ms	Duration fixation control	350 ms
Interstim.-interv. stimulus (+/-50%)	1700 ms	max. reaction time fixation control	2500 ms
Interstim.-interv. stimulus (extended)	2500 ms	Interstim.-interv. fix. contr. (+/-50%)	1000 ms
Distance pauses (0=no pauses)	60 s		

Reset
Apply

Fig. 9 : Parameter settings

Tab. 1: Settings of the test parameters

Parameter	17 " notebook (wide)	19" LCD monitor (4:3)	27" LCD monitor (wide)	32" LCD TV (wide)
Graphic resolution in pixels	1200 x 800	1280 x 1024	1920 x 1080	VGA 1024 x 768
Screen width x height	332 x 204 mm 13.1 x 8.0 in	387 x 298 mm 15.2 x 11.7 in	600 x 338 mm 23.6 x 13.3 in	700 x 395 mm 27.6 x 15.5 in
Distance eye- screen	450 mm 18 in	450 mm 18 in	500 mm 20 in	600 mm 24 in

Parameter	17 " notebook (wide)	19" LCD monitor (4:3)	27" LCD monitor (wide)	32" LCD TV (wide)
Line width	0.5 °	0.5 °	0.5 °	0.5 °
Size fixation point	2.5 °	2.5 °	2.0 °	2.0 °
Spot diameter stimulus	3.5 °	3.5 °	2.8 °	2.8 °
Background brightness	45	45	45	45
Brightness stimulus	170	170	170	170
Brightness fixation control	217	217	217	217
Number fixation controls	40 (60) %	40 (60) %	40 (60) %	40 (60) %
Duration fix control	350 ms	350 ms	350 ms	350 ms
Stimulus duration	200 ms	200 ms	200 ms	200 ms
ISI fix control (± 50%)	1000 ms	1000 ms	1000 ms	1000 ms
ISI stimulus	1700 ms	1700 ms	1700 ms	1700 ms
max. RT fix control	2500 ms	2500 ms	2500 ms	2500 ms
max. RT stimulus	2000 (2500) ms	2000 (2500) ms	2000 (2500) ms	2000 (2500) ms
Duration of testing interval	60 s	60 s	60 s	60 s

2.2 Instruction

During the instruction, the patient becomes familiar with the central and peripheral task. After a detailed explanation of the task it will be practiced with an exercise. If the "additional exercises" mode is activated, the central and peripheral task are exercised separately beforehand. After each instruction step, the result is reported back and there is the possibility to repeat the exercise or continue to the next step. The instruction by the test administrator is done verbally, the instruction text is presented on the screen in the unaffected hemifield. When the patient exhibits

neglect or hemianopic dyslexia, the test administrator should read the instruction aloud and show and explain the tasks.

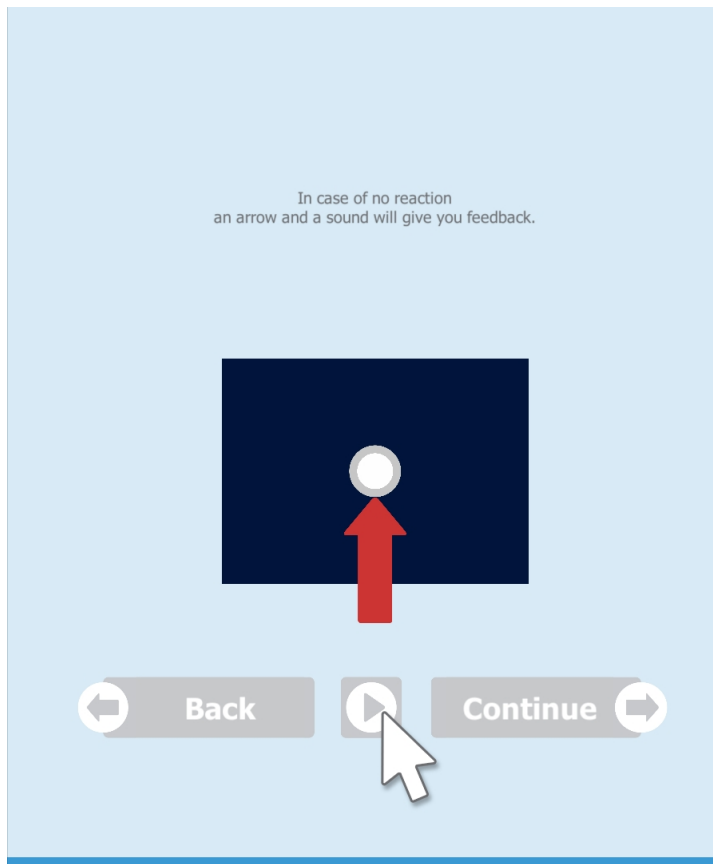


Fig. 10: instruction central task

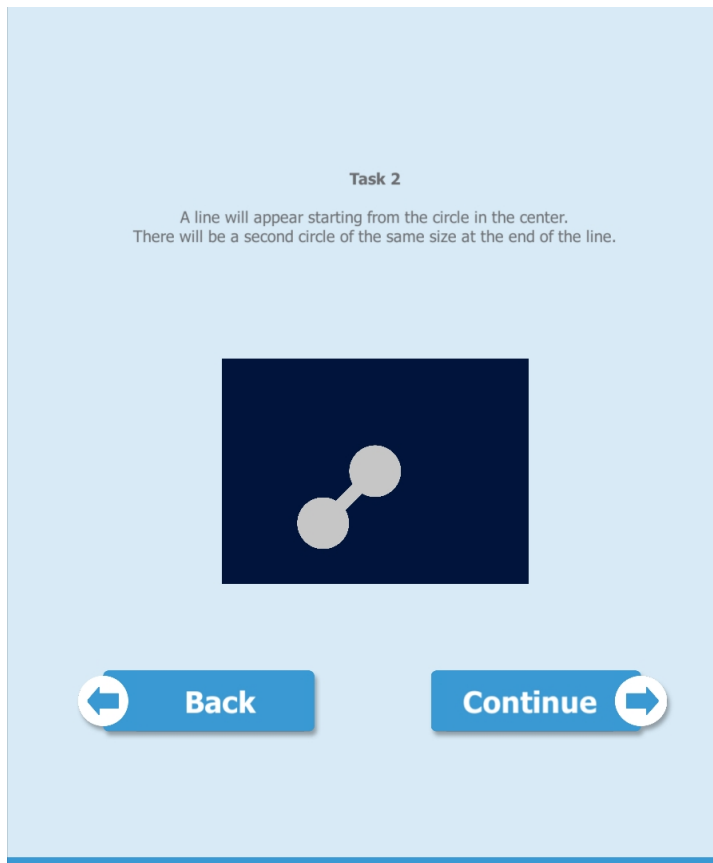


Fig. 11 : instruction peripheral task part 1

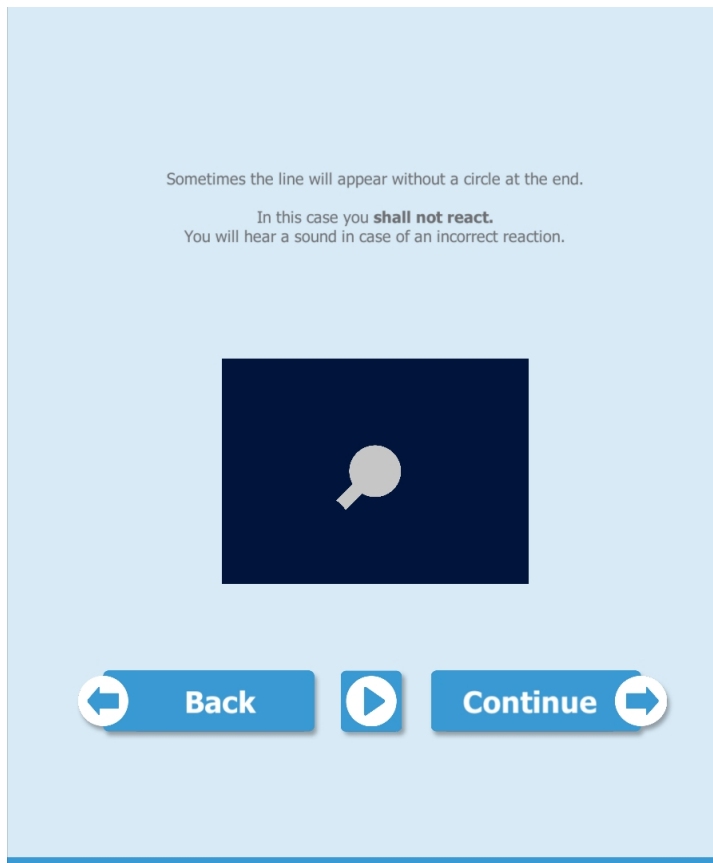


Fig. 12 : instruction peripheral task part 2

The exercise stimuli all appear in the unaffected hemifield (in most serious neglect, both hemifields can be affected, and focusing on the center and therefore the implementation of the central task usually is not possible. If this is the case, the testing should be postponed).

Nonverbal guided information on comprehension problems

For patients with aphasic related language comprehension disorder or with difficulty understanding how they should react to stimuli, the haptic instruction mode, the "non-verbally guided instruction" (Peschke, 2004) is used. In this case, the right hand of the therapist leads the right hand of the patient (or the therapist's left hand leads the patient's left hand) by gently resting on the patient's hand. The patient's hand is guided in correct responses or held if the patient reacts when irrelevant stimuli are presented. The therapist may also help the patient to learn when to press the button by pointing to the stimulus and commenting, telling the patient "yes, press" or "no, do not press." Aphasic patients should understand the task in a short period of time.

Especially in patients with left frontal brain injury, mistakenly reacting to irrelevant stimuli in the unaffected hemifield may still occur, even after several practice runs.

Usually, patients notice the errors and react in ways that are observable on facial expressions, in exclamations, or in body movements. In these cases, the exercise may be continued. The test administrator can use his or her observations to interpret the errors later in the right way (see test description above).

2.3 Testing

Implementation with breaks

The fixation point is displayed in the center of the screen during the entire test. The patient must focus on the center during the whole test and not look at perceived stimuli or scan the screen for possible stimuli.

To endure the eye fixation with focused attention, pauses for recovery are enabled in the Visual Field screening test. During the pause, the patient can move his or her eyes freely, the sitting position can be corrected, etc. The patient determines the length of the pause. The test execution is continued by pressing OK. The testing intervals between pauses are preset at 60 seconds.

The duration of the test therefore depends on the pause duration as well. Because of the breaks, the patient has to keep his high concentration alive only for one minute, which increases the reliability of the test.

Duration of the test

The duration of the test (without instructions) depends on both the (preset) parameters and the working behavior of the patient. You can preset the normal or the extended version with extended inter-stimulus intervals, maximum response times and an increased number of fixation controls.

With default settings selected, average response times of 600–800 ms, and short breaks, the test procedure takes about 10 minutes. If the patient has an attentiveness disorder, the test duration is longer.

2.4 Data analysis

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

Complete overview

In the Visual Field screening module, two values for the left and right hemifield are calculated (Percentile rank, T-Norm and Z-Norm) and displayed in the overall view. In

the overall view, the standard deviations of the T-Norms for omissions per hemifield are displayed.

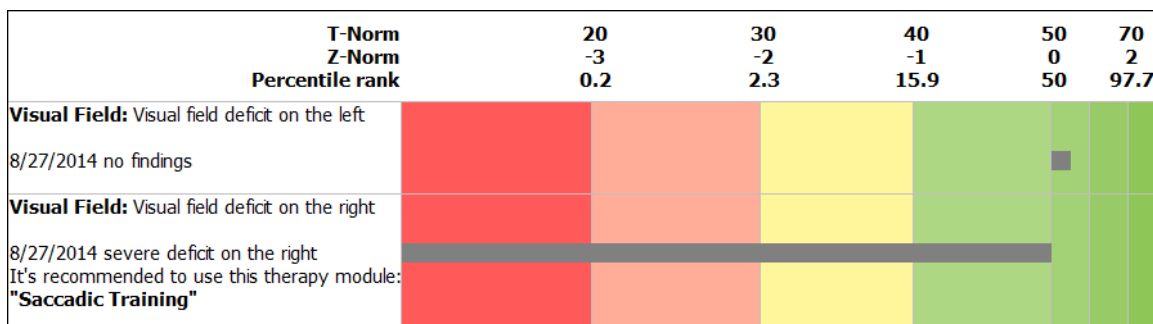


Fig. 13: Overall view visual field (both hemifields)

The standard deviation for omissions is calculated to be 7% of the missed stimuli in a hemifield of potential $2 \times 24 = 48$ omissions (100%). The standard deviation reflects omissions significantly above those exhibited by a healthy control group and allows for a clinically reasonable interpretation that a patient has a deficit in his or her visual field. At 2 standard deviations below the mean, a manifested visual field deficit in the affected hemifield is shown.

For example, a patient does not respond to 34 relevant stimuli in the right hemifield - about 71% omissions (see fig. 14 & 15). By the empirical definition (7% omissions = 1 standard deviation), a T-value of 0 is calculated. In the overview, the gray bar extends to 0 in the red zone for the right hemifield. For the left hemifield, no omission is registered, so the gray bar remains in the green zone.

When interpreting results, additional values should be considered. For instance, a small remaining neglect may show minor or no omissions (T-score > 40), but the reaction time may be significantly different between the hemifields.

Detailed results are shown by double clicking the Visual Field section in the overall results or via the Details button.

Table of the major performance results

At the top of the table in the Details view, the four major performance values of the two hemifields and four quadrants are displayed. At the bottom of the table, the secondary results for performance and quality, including the most important settings of the test parameters, are shown.

HASOMED RehaCom® Visual Field						
	Left HF	Right HF	Top Left	Bottom Left	Top Right	Bottom Right
Correct	48 (100%)	14 (29%)	24 (100%)	24 (100%)	7 (29%)	7 (29%)
Median Reac. Time [ms]	517	550	512	520	571	547
Omissions	0	34	0	0	17	17
Mistakes	2	2	0	2	1	1
Fixation accuracy / reactions on central stimuli: 56 (97%) Selectivity / correct omitted reactions on irrelevant stimuli: 44 (92%) Reactions in interstim. interval: 0						
Testparameters: Portion fix. contr: 40%; central fix. stims: 58; peripheral stim. total: 96; irrelevant stimuli total: 48 Visual field deficit: Right; Interstim. interv.: 1700ms; stim. duration: 200ms; max. reac. time: 2000ms						

Fig. 14 : Performance results and test parameters

In addition to the number of correct and omitted reactions, the median reaction times are important values. Differences between the median of the reaction times of both hemifields can point to neglect symptoms. Slowdown in one hemifield may give a hint to a slower shift of attention or decreased contrast sensitivity in the contralesional hemifield and should be clarified with further diagnostics. The patient's scores for fixation accuracy (% of responses to the central fixation stimulus) and selectivity of the reaction in the peripheral task (% correct inhibitions) are important. In the example, the patient gets a value of 100% fixation accuracy when the central task accounts for 40% of the stimuli, which shows that the patient is able to focus well. The selectivity is 92% (with 4 non-inhibited reactions evenly distributed between the hemifields), which is still in good range and shows no significant side effects.

Visual field graphic

The graph shows the evaluation of the stimulation in the hemifields and quadrants.

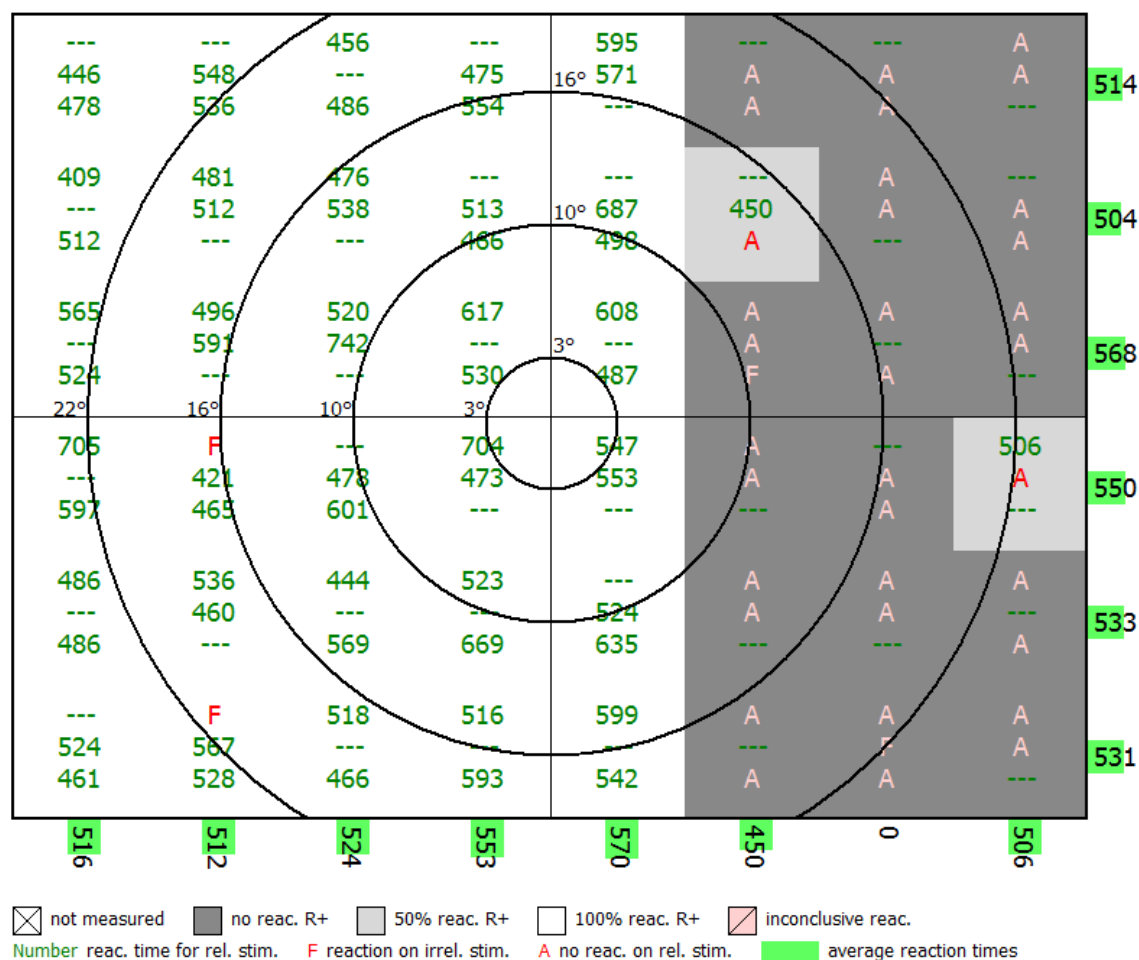


Fig. 15: Reaction at the stimulation sites of the measured visual field

White areas indicate that the patient reacted correctly to both relevant stimuli for the given position (RR 100%). The green numbers at the position of stimulation in the quadrants indicate the reaction times for the relevant stimuli in ms. The green shaded numbers at the edges of the graph indicate the average value of the reaction time to relevant stimuli in the respective row and column. Long reaction times indicate a slowdown of the patient.

Light gray areas are displayed at positions where the patient reacted correctly to only one of the relevant stimuli (RA 50%). An omission is indicated with a red **A**. Dark gray areas are visible at positions where the patient did not react to either of the relevant stimuli (AA 0%), which suggests that a perception and reaction deficit is present.

If the patient reacts to irrelevant stimuli, a red **F** is shown at the site of stimulation. The concentric circles indicate the measured visual angles. The displayed values may vary depending on the display size and the patient's distance from the screen (see screen size in the chapter "[Parameter settings](#)").

Process graph

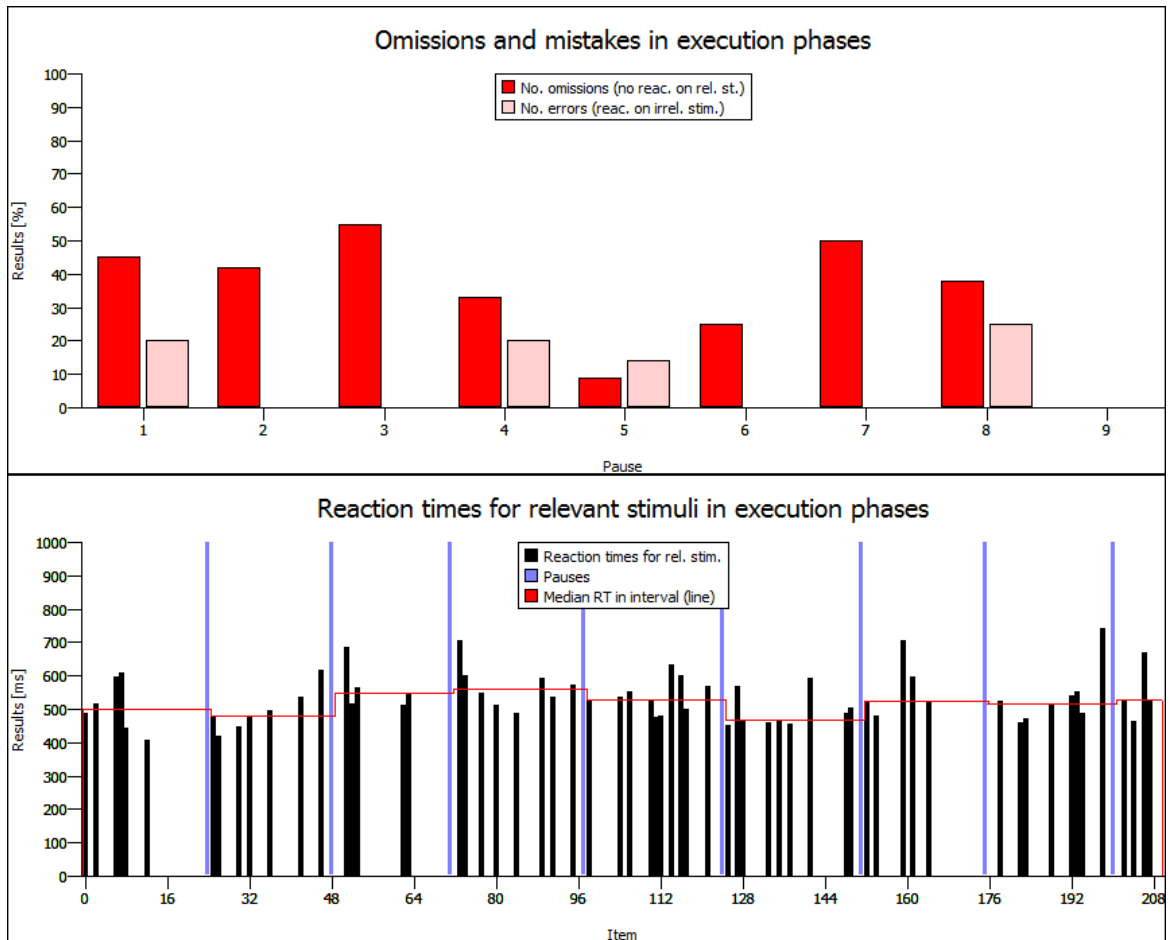


Fig. 16: Course of the performance quality

The first graph shows omissions and errors during the testing intervals. In the example above, 8 pauses were made.

There were reactions on irrelevant stimuli in four intervals (error = light red bar).

The second graph shows the reaction times of all relevant stimuli (black bars), and the duration of pauses (blue bars).

The red line shows the median of the reaction times in the interval between pauses.

An increase of errors or reaction times during the course or towards the end of the test indicates fatigue and declining concentration and has to be considered as an intervening variable in the interpretation of a visual field deficit.

3 Training

Visual field deficits which are made visible with the Visual Field screening module (T-norm < 40), may have various causes (further differential diagnostic is necessary to determine the cause) and require, depending on the cause, a different therapeutic approach for the use of PC-based methods:

- In the case of hemianopsia and quadrantanopsia, a compensatory eye movement training (or restitutive stimulation training) and also reading practice in the event of hemianopic reading disorder are recommended.
- In the case of neglect, a restitutive exploration training and eye movement training, optionally with optokinetic stimulation, neck muscle vibration or prism glasses as well as reading practice in the event of neglect dyslexia are recommended.
- In the case of neglect and hemianopsia/quadrantanopsia, the neglect therapy is the first step. When the neglect has regressed, the hemianopic therapy can follow.

In case of existing basal attention deficits, a concurrent or preceded alertness training and a training involving selective attention performances can be useful as well. The choice of therapy focus depends on the patient's diagnosis.

While training the eye movement (saccadic training) in hemianopsia, the practice and automatization of an efficient eye movement strategy is important. Hemianopic patients tend to implement eye movements in the unaffected eye and unaffected visual field first - they should learn to first implement large eye movements in the affected visual field and then use a scanning strategy (not chaotic) for smaller movements (comp. Zihl & von Cramon, 1986; see also the manual for the Overview and Reading therapy module).

The exploration training of the neglect patient differs clearly from the saccadic training of the hemianopic patient, although it is implemented with the same programs (e.g. Saccadic Training). The neglect patient requires verbal cues and helpful prompts for the (often difficult) exploration of the affected hemifield until the target stimulus was detected (e.g. by following the horizon line in the Saccadic Training module). Large saccadic eye movements to the affected site are not possible for the patient.

In case of severe neglect, the sitting and head position has to be aligned as well as the searching eye focus has to be guided by the use of a pointer that is run by hand (Peschke, 2004). The combination of visual and haptic perception when using the pointer (the eyes follow the pointer which is touching the monitor noticeably) should be understood as a way of multimodal stimulation in neglect.

The following RehaCom modules and groups are preferably recommended for the training therapy of hemianopsia or neglect:

- **Saccadic Training** - Saccadic and exploration training, in neglect optional with optokinetic stimulation and extinction conditions in case of double objects
- **Restoration Training** - stimulation of the visual field borders
- **Overview and Reading** - eye strategy training / exploration training and reading practice
- **Visual attention** - exploration and search training (requires language skills)

In slight disorders, the modules **Reaction Behavior** and **Divided Attention** can be used in the lower levels.

In case of existing basal attention deficits, a concurrent or preceded alertness training and a training involving selective attention performances can be useful as well. The choice of therapy focus depends on the patient's diagnosis.

4 Bibliography

Diener, H.-C., Weimar, C., Berlit, P., Deuschl, G., Elger, C., Gold, R., ... Weller, M. (2012). *Leitlinien für Diagnostik und Therapie in der Neurologie* [Guidelines for diagnosis and therapy in neurology] (5th ed.). Stuttgart, Germany: Georg Thieme Verlag.

Heilmann, K. M. (1979). Neglect and related disorders. In K. M. Heilmann & E. Valenstein (Eds.), *Clinical Neuropsychology* (pp. 268–307). New York, NY: Oxford University Press.

Karnath, H. O. (2003). Neglect. In H. O. Karnath & P. Thier (Eds.), *Neuropsychologie* (pp. 217–230). Berlin, Germany: Springer.

Karnath, H.-O., & Zihl, J. (2012). Rehabilitation bei Störungen der Raumkognition. Retrieved from www.dgn.org/leitlinien

Kerkhoff, G. (2004). Neglect und assoziierte Störungen. *Fortschritte der Neuropsychologie* (Vol. 1). Göttingen, Germany: Hogrefe.

Peschke, V. (2004). Handanweisung Burgauer Bedside-Screening. www.psydat.de

Stone, S. P., Wilson, B., Wroot, A., Halligan, P. W., Lange, L. S., & Marshall, J. C. (1991). The assessment of visuo-spatial neglect after acute stroke. *Journal of Neurology, Neurosurgery and Psychiatry*, 54, 345–350.

Zihl, J. (2003). Zerebrale Blindheit und Gesichtsfeldausfälle. In H. O. Karnath & P. Thier (Eds.), *Neuropsychologie* (pp. 73–83). Berlin, Germany: Springer.

Zihl, J. (2006) Zerebrale Sehstörungen. In: Karnath, H.-O.; Hartje, W.; Ziegler, W. (Eds), *Kognitive Neurologie* (pp. 1–18). Stuttgart: Thieme.

Zihl, J. & von Cramon, D. (1985). Visual field recovery from scotoma in patients with postgeniculate damage. A review of 55 cases. *Brain*, 108(2), 335-365.

Zihl, J. & von Cramon, D. (1986). Zerebrale Sehstörungen. Kohlhammer: Stuttgart.

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