Mirrored Therapy
Practical Protocol for Stroke Rehabilitation
Andreas Rothgangel
Susy Braun
Preface

The main reason to develop a practice-based protocol was because mirror therapy is still inconsistently used in clinical situations and many physical and occupational therapists expressed a strong need for some form of guidance to structure therapy and support implementation of mirror therapy in routine care. As in most protocols, evidence based practice was the starting point: Evidence from literature, clinical experience from therapists and patient preferences* were taken into account to determine the content and select the examples.

As in almost all specific rehabilitation interventions, effect sizes for mirror therapy are still relatively small and new evidence might overturn existing evidence. Mirror therapy should therefore be considered as one of several therapy interventions within a rehabilitation programme where other interventions can be offered as well, or sometimes may even be preferred.

The present protocol should be seen as a framework, not a predefined recipe for all patients. Within the protocol the basic principles and many examples of how to apply mirror therapy are given. The framework however leaves enough room for the therapist to adjust the protocol and tailor it to the abilities and preferences of his / her patient. This way the clinical experience and the preferences of therapists are incorporated in the protocol as well, making it easier to use the protocol in everyday practice. A critical mind is of course still required.

The first version of this protocol for mirror therapy was developed by Andreas Rothgangel and Susy Braun together with students of Zuyd University of Applied Sciences (Heerlen, The Netherlands) as part of their physiotherapy bachelor thesis in 2011. The protocol was published in the German Journal of Physical Therapy in 2012. Since then the protocol has been updated, expanded, restructured and translated into English. New evidence and experiences have been incorporated into this second version. Also, the content has been restructured with two overview figures being added. The protocol is now presented in the order a professional would need to start providing mirror therapy in everyday practice.

We hope that this protocol facilitates the tailored treatment of patients after stroke with mirror therapy in everyday care.

Andreas Rothgangel & Susy Braun July 2013

* A group of twelve german occupational and physical therapists and three stroke patients was interviewed.

Acknowledgment

We would like to thank the students who were involved in the first drafts of this protocol. All therapists and patients involved in the developmental stage of the protocol should be acknowledged: Thank you for sharing your experiences and thoughts with us. Many thanks to Frank Aschoff and Dr. Annie McCluskey for making this project happen.

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Introduction

Stroke is a major cause of limitations in the everyday activities of patients, often leading to dependency on long-term care (1). In particular, recovery of upper limb function is challenging (2, 3). Currently there is limited evidence that specific treatment methods are more effective than others. However, we do know that treatments should include high-intensity, repetitive tasks-specific and goal-oriented practice with feedback on performance (4). Several treatment strategies have emerged during the last few years that try to incorporate these elements, such as constraint induced movement therapy, mental practice and mirror therapy (4). First applied in patients with phantom limb pain following amputation (5), mirror therapy was soon used to treat hemiparesis in stroke patients (6).

The principle of mirror therapy is simple: When looking into the mirror, the patient observes the reflection of the unaffected limb positioned as the affected limb. When performing motor or sensory exercises with the non-affected limb, the reflection in the mirror is often perceived as the affected, paretic limb. This strong visual cue from the mirror can therapeutically be used to improve motor performance and the perception of the affected limb (7, 8). Recently a Cochrane Review (8) was published that indicated evidence for the effectiveness of mirror therapy in improving upper limb motor function in stroke patients. The effects of mirror therapy have mainly been related to the activation of mirror neurons, which may also be activated when observing others perform movements and during mental practice of motor tasks (9, 10). In addition, activation of brain areas that are associated with enhanced self-awareness, spatial attention and recovery from neglect such as the superior temporal gyrus have been shown to be activated by mirror therapy (11–13).

Despite emerging evidence regarding the effectiveness of mirror therapy in stroke patients, one systematic review (7) has shown that many variations in treatment protocols for mirror therapy still exist, such as the type of movement performed. For example, patients have been instructed to move the unaffected limb only (14–16) or both limbs in a synchronized manner, as much as possible (17–20). Additionally, therapists have supported the movements of the affected limb in one study (21). The currently available evidence does not allow any firm conclusions on which of these treatment characteristics are more effective. The fact that variations in treatment protocols exist led to the development of this practical protocol that could help implementation of mirror therapy in routine care. Besides published evidence, substantial parts of this protocol reflect the opinion and experience of a group of therapists. This protocol was specifically designed to facilitate quick and easy orientation, allowing therapists to get a general idea about the basic approach when using mirror therapy following stroke.

The protocol is structured as follows: First, guidance is provided about selecting and treating eligible patients. Next, the content of the first treatment session is described in detail, followed by examples of exercises that can be used in subsequent therapy sessions. Finally, ways of facilitating unsupervised training and relevant literature are provided.

Notes: The emphasis of this practical protocol is on arm and hand training as evidence is stronger for upper limb mirror therapy. However, the principles described in this protocol also apply to the lower limb. The examples are given to show the scope of application possibilities.
Characteristics that are important when choosing eligible patients are first described, followed by treatment aims and how the circumstances and materials can be chosen in relation to the goals of treatment. Finally, we describe different intervention characteristics that should be considered before starting treatment.

Patient characteristics

The following patient characteristics are important to consider when choosing patients for this kind of treatment. These characteristics were derived from clinical experience of therapists and the selection criteria used in published studies (7, 8).

Motor abilities

The available evidence does not provide clear advice or guidance about who to select for mirror therapy based on the level of motor ability or severity. In one study (18) it was suggested that mirror therapy is more effective for stroke patients with severe paresis or even a flaccid upper limb. Other studies (7, 8) and clinical experience suggest that patients with better motor ability also benefit from the treatment.

Cognitive abilities

Eligible patients should have sufficient cognitive and verbal abilities (e.g. attention, working memory and concentration) to focus at least for ten minutes on the mirror reflection and follow instructions given by the therapist. Patients with severe neuropsychological deficits such as severe neglect or apraxia are less suitable for mirror therapy. Given the fact that many patients in the acute phase have limitations in cognitive abilities, one might argue that mirror therapy is less applicable in this stage after stroke. However, the optimal starting point of mirror therapy after stroke is unclear; the same applies to the phase of recovery in which mirror therapy is the most effective. We do know that after the occurrence of stroke most recovery takes place within the first six to twelve months (3). Most of the studies on mirror therapy were conducted in patients within this time frame after stroke (7, 8). However, some cases are reported in which improvement of motor functions was also achieved after several years post-stroke (17).

Vision

In case of visual impairments (e.g. hemianopsia), therapists should determine if a patient can see a clear image of the entire limb in the mirror. Patients with visuospatial neglect should be able to turn their head towards the mirror image when asked to do so and keep their attention focused on the mirror image at least for five to ten minutes.

Trunk control

Patients should have sufficient trunk control to be able to sit unsupervised in a wheelchair or a normal chair for the duration of the treatment.

Cardiopulmonary function

Patients with cardiopulmonary abnormalities, who are not able to sit for the duration of the therapy, are not eligible for this kind of treatment.

Non-affected limb

The non-affected limb should ideally have a normal and pain free range of motion. Severe constraints of the non-affected limb (e.g. range of motion, pain) could hamper execution of mirror therapy exercises.

Treatment aims

The existing evidence (7, 8, 22) supports the positive effects of mirror therapy in stroke patients on the following domains:

- Improving motor function and ADLs
- Reducing pain
- Reducing neglect
- Reducing sensory impairment

Effects on spasticity have not yet been established in clinical studies, but clinical experience from participating therapists suggests that mirror therapy may help with the short-term reduction of spasticity in patients with stroke.
Informing the patient

Before the first session, patients should be sufficiently instructed about the background and aims of mirror therapy as well as possible side effects of the treatment. Furthermore, patients should be able to engage in this kind of treatment and that they will be asked to imagine that the mirror image is their affected limb. There are indications that the intensity or vividness of the “mirror illusion” may predict the outcomes of the treatment (23). For this reason, jewellery and other visual marks should be removed to make it easier for the patient to perceive the reflection as their affected limb when looking into the mirror. Patients should have realistic expectations with respect to the improvements that are achievable by using mirror therapy. They should be made aware of the importance of continuous, frequent training and self-management.

Possible negative side effects

The mirror image of two intact limbs can evoke emotional reactions (24). Other reactions like dizziness, nausea or sweating can be triggered in individual patients when observing the mirror reflection. In such cases, patients are instructed to no longer look into the mirror but to focus on the unaffected limb or another point in the room. The mirror can be pulled away a little from the patients’ body, so that only a part of the affected limb (e.g. the hand) is covered by the mirror. Patients should then be instructed to observe the mirror image only over a short period of time and then turn their gaze away towards the unaffected limb. This procedure should be repeated several times, until the side effects resolve.

Environment and required materials

Surroundings

As stated before, patients need to have sufficient attention and concentration when using mirror therapy, which implies that at least during the first sessions the environment should be free of other stimuli that attract the patients’ attention. For the same reason at least the first sessions should be delivered individually instead of in a group, especially in easily distracted patients.

Jewellery and other marks

The mirror image has to match with the perception of the affected limb in order to facilitate an intense mirror illusion. This means that jewellery should be removed from both limbs before starting the treatment as far as it hinders the patient when looking into the mirror. The same applies to other visual marks on the non-affected limb such as birth marks, scars or tattoos that should be covered if they prevent a vivid image (e.g. with a plaster, glove or make-up).

Mirror

The dimension of the mirror should be big enough to cover the entire affected limb and should allow patients to see all major movements in the mirror (fig. 1). A size of 25 x 20 inches for the upper limb and at least 35 x 25 inches for the lower limb should be large enough for everyday usage.

There are mirrors available made of different materials (glass, foil, acrylic glass). When choosing a mirror one should pay attention to the following aspects:

- It should provide a coherent mirror image without any noteworthy distortion.
- There should be no risk of injury, e.g. through the edges of the mirror.
Exercise materials
Besides objects that are needed for functional motor training (e.g. cups, towels) materials with more sensory input can be used, especially in patients with impairments in body perception (fig. 2), like:
- Plastic bowl or tubs filled with sand or peas
- Hedgehog ball
- Temperature stimuli (warm, cold)
- Different brushes
- Washing up gloves
- Sand paper

Treatment characteristics
Frequency of therapy & duration of sessions
The available literature (7, 8) recommends performing mirror therapy at least once daily with a minimum duration of ten minutes. The maximum duration of each session is dependent on the cognitive abilities of the individual patient and/or negative side effects, but in most cases will be around 30 minutes (7, 8). It is also possible to split one session into two shorter sessions of 10 to 15 minutes with a short break in between, if the patient’s abilities do not allow longer sessions. A daily treatment session using mirror therapy will be beyond the possibilities in many clinical settings. In such cases, patients will require instruction about unsupervised training using the mirror as early as possible, to enhance treatment intensity.
Position of affected limb
The affected limb should be positioned on a height adjustable table so that its position can be adjusted to the length of the patient’s trunk and arm. The affected limb is situated in a safe and preferably comfortable position behind the mirror. In case of severe muscle spasticity, preliminary manual mobilization may be necessary and helpful before positioning the limb.

Position of non-affected limb
The patient should try to facilitate a vivid “mirror illusion” (mirror image perceived as the affected limb) by matching the position and image of the non-affected limb to the affected side. For example, the non-affected limb should be positioned in a similar position as the affected limb, as this facilitates the intensity of the mirror illusion.

Position of the mirror
Generally, the mirror is positioned in front of the patient’s midline, so that the affected limb is fully covered by the mirror and the reflection of the unaffected limb is completely visible (fig. 3). In the case of visuospatial neglect or severe muscle spasticity in the affected limb, the position of the mirror can be adjusted in such a way that it points more diagonally towards the unaffected limb (fig. 4). The important point when adjusting the position of the mirror is to assure that the mirror image still matches with the perception of the affected limb.

Chapter II: First therapy session

After patients have been informed about the background and aims of treatment, basic assessment on the different domains of the International Classification of Functions (25) takes place, followed by positioning of the affected limb and the mirror on the table. The unaffected limb should take up a position similar to that of the affected limb.

Visual illusion
Next, patients are instructed to observe the mirror reflection for one to two minutes, trying to visualize the mirror image as the affected limb. Additionally, patients can be instructed to imagine looking through a window instead of a mirror, to enhance the vividness of the mirror illusion. The therapist can use bilateral, synchronous stimulation (e.g. tactile) to further facilitate the mirror illusion. The first exercises can start when the patient indicates that he / she perceives the mirror image as the affected limb.

Treatment approach in relation to the aim
After the first exercises on establishing a vivid mirror illusion the subsequent treatment approach is chosen according to the individual treatment aim. Generally, corresponding to the aim of the treatment, clinical experience has shown that the basic treatment approaches shown in figure 5 are useful. Based on experience, the approach used for improving motor function seems more tailored to the individual client, depending on the vividness of the mirror image and type of motor performance. Contrary to the more tailored approach used for improvements in motor function, the treatment approach used for improving neglect, muscle tone, sensation or pain is more standardized.

Depending on the capacity of an individual patient to process information, the amount of stimuli must be adapted (fig. 6). For example, in patients with hypersensitivity or pain after stroke, the amount of stimuli applied to the affected limb should be minimized. The latter implies that motor and sensory stimuli are applied to the non-affected limb only; the intensity of these stimuli should be adapted to the individual’s pain threshold.
Fig. 5: Treatment approach in relation to the aim
Fig. 6. Amount of stimuli used depending on abilities and preferences of the individual patient
Chapter III: Training of motor function

Figure 7 gives an overview of the different steps taken when mirror therapy is used to improve motor function.

Step 1: Choosing an appropriate motor exercise
Over the first two to three weeks, therapists generally start with simple exercises like flexion and extension movements of the fingers, wrist and elbow (fig 8). This is also the case in patients with a flaccid limb. In principle all degrees of freedom of the joints may be addressed. Most common is to start with the range of motion that can also be achieved in the affected side, slowly increasing the range and the complexity of the movements (“shaping”). Remember to apply the basic principles of motor learning: a high number of repetitions combined with variation of the movement performance.

Step 2: Execution of motor exercise
After the first exercise has been agreed upon, it can be visually or verbally demonstrated in the unaffected side with assistance of the therapist. Then the patient executes the movement according to the different options shown in table 1.

Step 3: Identifying the basic approach
Clinical experience suggests that the way movements are executed by the patient (tab. 1) should be based on the intensity or vividness of the mirror illusion. Therefore, the vividness of the mirror illusion should be evaluated after the first exercise has been executed (step 2). Each option for movement execution is repeated up to 15 times. After all options have been performed, the patient decides together with the therapist which exercise best facilitates a vivid mirror illusion. This option for movement execution

<table>
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<tr>
<th>Tab. 1_Options for movement execution (7)</th>
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<tbody>
<tr>
<td><strong>Motor exercises without an object</strong></td>
</tr>
<tr>
<td>Unilateral movements of the non-affected arm only</td>
</tr>
<tr>
<td>Bilateral movements (“as good as possible”)</td>
</tr>
<tr>
<td>Guiding of the affected arm by the therapist</td>
</tr>
<tr>
<td>Guiding of both arms by the therapist (fig. 9)</td>
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</table>
will sequentially be used for the next motor exercises. The complexity of these motor exercises depends on the severity of the paresis. All movements should be executed very slowly, as this facilitates the intensity of the mirror illusion.

**Step 4: Using functional tasks**

After this first phase consisting of basic exercises, additional functional tasks with different objects (e.g. cups, wooden blocks or balls) can be integrated into the treatment program.

**Step 5: Execution of functional tasks**

Again the therapist should first identify the best way to execute the individually chosen functional task (with object, Tab. 1). The different options for movement execution are performed according to the method described above (step 3).

**Step 6: Identifying the basic approach**

The basic approach used for training functional tasks also depends on the vividness and intensity of the mirror illusion. After all options have been performed, again, the patient decides together with the therapist which one facilitates a vivid mirror illusion most.

First, simple functional movements can be performed, like the sliding of an object over a surface (fig. 10). More complex movements, like grasping, carrying and placing of a cup in another position, can first be divided into easier movement parts. These parts or movement components are practiced repeatedly in isolation before grouped together again into an entire skill or activity (26).

**Structure of exercises in the case of moderate to mild paresis**

If the patient has moderate to mild paresis, the therapist may also choose to start mirror therapy with the simple...
basic exercises. Unlike the more severe paresis the complexity of exercises can be increased more quickly in these patients. As these patients will also benefit from other active functional interventions like forced-use (27), we leave it up to the judgment of the therapist to which extent he/she wants to use mirror therapy in this specific target population. One option would be to use the mirror in the context of constraint induced movement therapy as a preparation tool: Functional exercises are rehearsed in front of the mirror using the non-affected arm only. The patient watches the performance in the mirror closely. Then, the exercise is repeated with the affected arm only, this time not using the mirror (principle of movement observation).

Fig. 10_Functional training with objects
**Chapter IV: Neglect**

When treating patients with neglect one should consider its extent. The neglect should not be so severe that patients cannot face the mirror if asked to do so. The mirror can be placed in a slightly diagonal position to facilitate looking into it because this way the patient does not need to turn his / her head that far (fig. 4, p. 6).

**Structure and content of therapy**
The limbs are positioned in front of the mirror. First, directed by the instructions of the therapist, the patient will set his / her arm or leg in different positions. The treatment protocol by Dohle et al. (18) can be used, which means that different positions are coded with numbers. During mirror therapy treatment only numbers will be used by the therapist after which the correct position is assumed and observed. In addition bilateral sensory stimuli can be used as soon as a new position is taken.

Alternatively, positions can be demonstrated by the therapist and then imitated by the patient. After this initial phase of imitating positions the therapist can start with adding movement training to the basic exercises (see chapter III).

**Chapter V: Spasticity, Sensation and Pain**

**Reducing spasticity**

Mirror therapy appears anecdotally to have a positive but short-term influence on spasticity. However, these effects often last only for a short period because spasticity often increases as the patients become more active. In order to regulate spasticity the affected arm is positioned on a table. In case of extremely high tone it might be necessary to first reduce the stiffness manually to enable an arm position on the table. After that the mirror is positioned, and the non-affected arm is placed in a similar position to the affected arm. This is the starting point for the therapy session and the instructions of the therapist (tab. 2). Movements are performed with the non-affected side only, using movements directed opposite to the pattern of spasticity. In addition, several positions of loosened postures of the non-affected side can be observed in the mirror.

**Facilitating sensation**

In addition to motor exercises (see chapter III) bilateral, synchronous sensory stimuli are now increasingly being used. Patients should observe in the mirror the materials which may be applied like brushes (fig. 2).

Additionally, patients can feel and describe different materials such as sandpaper. The mirror may contribute to increases in sensation of stimuli on the affected side.

**Pain syndromes after stroke**

Potential syndromes and situations in which mirror therapy can be applied to reduce pain include the thalamic stroke syndrome or complex regional pain syndrome (14, 15). The latter should not primarily be caused by peripheral pathologies, like subluxation of the shoulder.

The affected limb should be positioned as comfortably as possible before treatment. To avoid aggravating the pain, motor and sensory exercises are carefully performed with the non-affected limb only (fig. 11). The sensory sti-
Sensory stimuli are first provided to pain free areas before applying these stimuli to the more painful regions on the non-affected side (tab. 3).

**General therapy suggestions**

Please take the following suggestions into account when applying a mirror therapy intervention:

- Start with basic exercises and continue with more complex functional tasks in a later stage.
- Tailor the exercises to the patient’s individual performance level.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Therapist</th>
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<tbody>
<tr>
<td>Performs unilateral movement exercises with the pain free non-affected limb; in addition sensory stimuli are applied to the non-affected limb.</td>
<td>Gives verbal instructions on the movement exercises and desensitizes the non-affected limb with a variety of sensory stimuli.</td>
</tr>
</tbody>
</table>

- Try to aim for as high a number of repetitions as possible (at least 15 reps per exercise), at the same time including variations of separate exercises with regard to range of motion, direction and starting position.
- Vary the exercises.
- Pay close attention to a slow movement performance (“slow motion”).
- The length of a single session depends on the abilities of the patient. If necessary, incorporate sufficient breaks.
- Check the gaze direction of the patient regularly in the mirror and give feedback about the exercise performance.

**Ending therapy sessions**

At the end of a therapy session patients should be prepared for viewing their affected limb again when the mirror is removed. If it helps the patient, some of the earlier performed exercises can be repeated without the mirror. Often patients can observe some improvement immediately after the therapy session already. The entire treatment should be evaluated with appropriate measurement instruments.

Fig. 11 Application of sensory stimuli to the non-affected side
Chapter VI: Facilitating unsupervised training

As soon as possible, patients should be instructed to perform unguided training. Once patients have understood the exercises and are able to perform mirror therapy without the guidance of a therapist, self-directed treatment should be initiated. In order to facilitate unguided mirror therapy it is useful to give written instructions (information sheet) and to ask patients to keep a log on their progress. An example of a mirror therapy log is given below (fig. 12).

### Mirror therapy – important recommendations for patients (information sheet)

- Consult your therapists or doctor when you are using mirror therapy and ask for feedback when you are unsure if you are performing the exercises correctly.
- The illusion in the mirror should be as realistic as possible. Therefore – if possible – take off all jewellery which is visible in the mirror (rings, watch).
- Important: Adjust the intensity of the exercises with regard to speed and range of motion depending on unpleasant sensations (e.g. pain) you might be experiencing. You may also want to vary exercises or change to another kind of exercise. You should always practice below your pain threshold. Neither during practice nor afterwards should you experience more pain than usual.
- Mirror therapy is more likely to be successful if you practice regularly. You should therefore try to perform your mirror therapy exercises at least once a day for at least 10 minutes.
- When starting with mirror therapy you should perform your exercises in a quiet surrounding to avoid distraction as much as possible.
- The affected body side / limb should be hidden by the mirror while you are practising.
- It is essential that you concentrate on your arm or leg in the mirror during the entire time you are practising. Try to imagine that the reflection of your non-affected limb in the mirror actually is your affected limb. In most cases the exercises will be more beneficial the more vivid or realistic your imagination is.
- Try to avoid looking at your non-affected limb during practice.
- Perform the movements slowly and with focus. The longer the symptoms have been existing, the slower you should proceed.
- Use a log to record your exercise progress: How often and for how long have you performed which exercises? What effect does the mirror therapy have on your complaints? Are there any unintended side effects?

### When to stop mirror therapy?

A minimum duration of five to six weeks of continuous mirror therapy treatment should be performed in order to evaluate possible effects of the treatment. The total duration of the treatment depends on how long improvements in functions are perceived by the individual patient and / or the therapist or to which extent the patient thinks that the treatment is beneficial. The treatment should be stopped in case of persistent negative side effects or if unguided training only is sufficient.

For your consideration: Mirror therapy can be used together with other cognitive treatments such as mental practice or limb laterality recognition (26, 28, 29). Mental practice could be facilitated by using the mirror image or audio tapes.
CHAPTER VI: FACILITATING UNSUPERVISED TRAINING

PROTOCOL

LEITFADEN

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Name:

Mirror therapy log

Week ___

Exercises for this week:

1
2
3
4
5
6

Fig. 12_Mirror therapy log (26) (⇒ appendix)

Evaluation of mirror therapy

<table>
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<tr>
<th>When did you practise (time of day)?</th>
<th>How long did you practise (minutes)?</th>
<th>Which exercise did you practise (number)?</th>
<th>How vivid was the mirror illusion?</th>
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Comments:

How are you feeling today?

Monday: ___-___-______

How are you feeling today?

LITERATURE


Authors of this practical protocol “mirror therapy for patients after stroke”

**ANDREAS ROTHGANGEL**

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Mirror therapy log

Week ___

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How are you feeling today?

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**Tuesday, ___-___-______**

How are you feeling today?

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### Evaluation der Übungen

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Comments:

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Thursday, ___-___-______

How are you feeling today?

![Smiley faces]

### Evaluation der Übungen

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**How are you feeling today?**

😊 😐 😞

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