Use of movement imagery in neurorehabilitation: researching effects of a complex intervention

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Since the beginning of the new millennium, the use of mental practice and movement imagery within several medical professions in rehabilitation and therapy has received an increased attention. Before this introduction in healthcare, the use of movement imagery was mainly researched in sports science. Mental practice is a complex intervention. When a complex intervention is applied in a new target group or population, the intervention is most likely needed to be adjusted, developed, and evaluated. Recently, a dissertation has been published in which the researchers describe their efforts to transfer the use of movement imagery in sports to rehabilitation. This study reports two aspects from this research project: (a) What did the researcher do? (b) What do the results mean for future research? First, however, some background information is given, in which the use of movement imagery in athletes is discussed. *International Journal of Rehabilitation Research* **34:203–208 © 2011 Wolters Kluwer Health | Lippincott Williams & Wilkins.**

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Introduction

Athletes use many different psychological skills to achieve ultimate performance, such as focusing, psyching up, goal setting, and movement imagery. Consequently, most people know the use of mental practice and movement imagery from sports. On television, athletes are frequently shown with their eyes closed and judged by the minimal body movements one can see that they are mentally rehearsing their motor tasks: alpine skiers descending in mind, high jumpers visualizing the perfect jump, and swimmers or ice skaters perfecting their race. Movement imagery is described as 'a conscious quasi-perceptual experience of movements through performing the movement in mind'. The sensations are, therefore, generated by thought and occur in the absence of the overt movement. Mental practice is defined as 'a training or therapy form in which an internal representation of the movement is activated and the execution of the movement repeatedly mentally simulated, without physical activity, within a chosen context' (Boschker, 2001).

How do athletes use mental practice?

Apart from the use of mental practice during competition and training, it is also used during periods in which athletes are recovering from injury (Martin *et al.*, 1999). The use of imagery by injured athletes is most similar to the use of imagery by people undergoing rehabilitation. Imagery behavior of injured athletes has been assessed and results show that athletes use imagery for several purposes such as improving motor skills, reducing fear of reinjury, and coping better with pain. Athletes seem to have individual preferences when using imagery. Reported imagery sessions differ from 5 to 30 s. Some, but not all, athletes are able to generate sensations during imagery, such as smell, kinesthetic sensations, and sounds. Most athletes report perceived benefit from the use of imagery (Driediger *et al.*, 2006).

What did the researchers do?

Many people who suffer from stroke complain about fatigue and lack of fitness. Both aspects limit physical practice in these patients. Imagery seems a potential alternative to increase therapy amount in a safe way. However, the mental practice intervention will most likely need adjustments before it can be applied in patients with neurological conditions. Research into the use of movement imagery in patients with neurological conditions can be considered as research assessing the effects of a complex intervention in a population with complex pathology.

Determining effects of complex interventions is not easy. Craig *et al.*, 2008 of the Medical Research Council (MRC) have presented a model in four steps, in which complex interventions are developed and evaluated. Those four steps are: (a) determining working mechanisms, modeling; (b) developing materials, testing intervention in feasibility, and pilot studies; (c) performing bigger trials, in which randomization is used, followed by full evaluations; and if appropriate (d) implementation (Fig. 1).

Recently, a dissertation on the subject was published. In the underlying research project, the researchers tried to make the transfer from sports science to rehabilitation (Braun, 2010). In this study, two aspects of this

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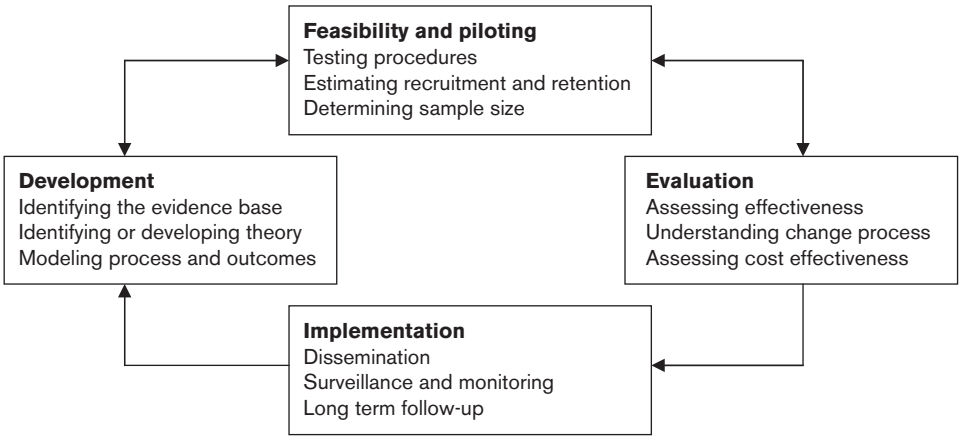
Fig. 1



Key elements of the development and evaluation process (model of the Medical Research Council guide).

dissertation are discussed: (a) What did the researcher do? (b) What do the results mean for future research and for the professional in daily care? The MRC model is used as a guideline to answer both questions.

Step 1: determining working mechanisms, modeling

Mental practice has received quite some criticism over the last century, because, for a very long period, the effect of mental practice could not be entirely explained by a model or theory. This changed when research on brain activity was introduced and recognized in the 1980s and 1990s. The technology behind functional magnetic resonance imaging and positron emission tomography scans underwent big developments, enabling more research in this area. Results from these fundamental studies showed that during movement imagery, approximately the same brain areas are active as during the performance of the movement (Nair *et al.*, 2003). Fundamental research is mainly targeted at healthy adults (Sharma *et al.*, 2006) and not at elder individuals (with or without acquired injury of the central nervous system). Therefore, it is still unclear to which extend the localization of, for instance, a brain lesion in older persons affects the ability to imagine and therefore affects possible effects of mental practice. It is of importance to perform more research to get more insight into relations.

Mental practice was first applied from 2000, as an additional therapy module in patients with stroke. In a review in 2006, it was concluded that mental practice as an additional intervention could contribute to an enhanced recovery (Braun *et al.*, 2006). However, the included studies had small population sizes and were hard to compare. Although definite conclusions could not be drawn, the technique seemed promising in the treatment of patients after stroke. Other, later published reviews came to the same conclusions. Less research has been undertaken to assess the possible effects of mental practice in patients with Parkinson's disease. Only two clinical studies were found. In one study, mental practice did not seem to improve micrography (small hand writing). In the other study, assessing bradykinsia (slowness of movement), patients did seem to benefit from mental practice resulting in less effort needed to move (Tamir *et al.*, 2007).

Although the potency of mental practice for several neurological populations had been established in theory (Jackson *et al.*, 2001) and small clinical studies, uncertainties remained even after a thorough literature search; mental practice content varied in the published studies (How should mental practice be applied?), and there was also a huge variation in the used measuring instruments and variables on 'Which level should outcome be assessed and with which measuring instruments?'. These questions were systematically assessed in the next step.

Step 2: developing materials, testing intervention in feasibility, and pilot studies

As a first step, the research group developed the intervention based on sports literature and evidence from guidelines and reviews from rehabilitation (Van Peppen *et al.*, 2004). Training principles from sports are known to be valid in rehabilitation as well. For instance, patient-selected goals need be practiced in context-specific surroundings in a functional manner. Conditional variables, such as, mobility and strength also need to be trained to enable functional practice. In addition, similar to sports, if the physiological boundaries of fatigue and adaptation are respected (overload principle), the more patients practice, the larger the effects are.

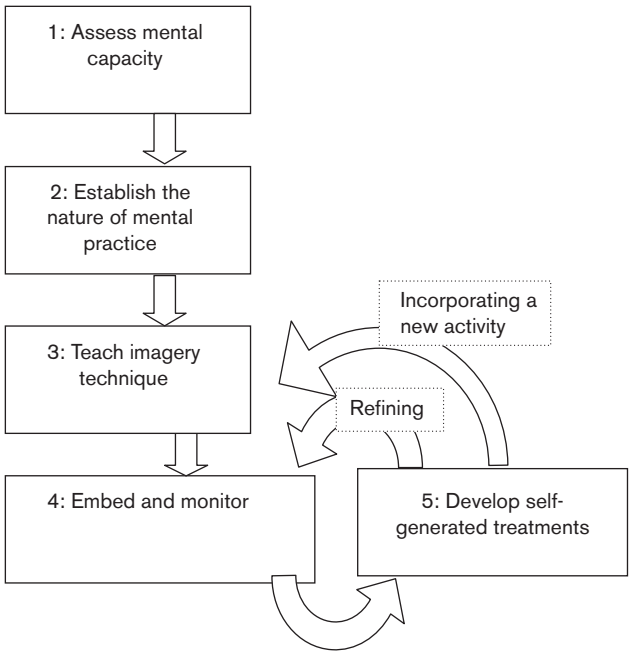
Another key element of the intervention was that many physiotherapists and occupational therapists should be

able to instruct the mental practice intervention. Therefore, it seemed essential that the intervention could be tailored to the patients' individual needs; patients have different levels of functioning and set other goals. During the development of the mental practice intervention, we choose to describe a theoretical framework, in which individual adjustments could be made. The intervention period was set at 6 weeks.

The theoretical framework to apply mental practice was divided into five steps (Fig. 2).

The first step is for the therapist to decide to use clinical judgment of whether the patient is a suitable candidate for mental practice by assessing the mental capacity of the patient to participate. The following two steps aim at teaching the patient the correct technique. As soon as the patient is able to apply imagery, he/she is encouraged in the third step to practice mentally without supervision of the therapist. Of course, the imagery technique and content need to be refined and upgraded with the improvements of the motor performance (step four). During motor recovery, it is therefore important that the therapist also pays attention to the improvement of the mental skills. The last step is not possible for all patients, but for those who are capable, the patient should learn how to develop self-generated treatments (step five). Therapists' support should gradually be reduced and the patient should be motivated to use and develop practice after discharge. Former patients should be able to contact the therapists again if problems arise.

Fig. 2



Overview of the steps taken in the mental practice intervention protocol.

In a preliminary study, the developed material was tested in feasibility studies and a few case studies were conducted. The results were positive and therefore larger randomized trials were planned and performed.

Step 3: performing bigger trials, in which randomization is used, followed by full evaluations

Within this project, two separate clinical trials were conducted in which mental practice was compared with a control group; one study was on individuals after stroke and one on individuals with Parkinson's disease. Participants were allocated randomly to the control or mental practice group. In both studies, the research question was as follows: What are the effects of mental practice on the physical functioning in patients with an acquired injury of the central nervous system?

In individuals after stroke, we wanted to know whether mental practice in the experimental group would increase or accelerate motor recovery (bigger or quicker recovery). This motor recovery was measured in the tasks 'walking' and 'drinking' and in two other, by the patient individually chosen activities.

In total 391 patients, in which the stroke did not occur more than 10 weeks earlier, in three nursing homes (Klevarie Maastricht, St Camillus Roermond, and Sevagram Heerlen, the Netherlands), were screened for potential participation in the trial. Of these patients, 65 were eligible and 36 eventually gave informed consent and participated in the trial.

In patients with Parkinson's disease, we wanted to assess whether motor deterioration could be slowed or if motor performance could even be (slightly) improved in the experimental group by applying mental practice.

The motor performance of the task 'walking' was assessed. We screened 59 patients on potential participation and 47 patients were enroled in three practices in the community (fysiotherapiemaatschap Snijders Stein, Fysiovision Geleen en fysiotherapie de Baandert Sittard, the Netherlands), the Policlinical Physiotherapy Department of the Orbis Medical Concern Sittard and the nursing home St Camillus Roermond, all located in the South of the Netherlands.

What did treatment look like and what were the outcome measures?

To determine the possible effects of mental practice, two groups were compared with each other; a group with (the experimental group) and a group without mental practice (the control group).

The treatment therapy of the experimental group lasted for 6 weeks and consisted of therapy as usual according to the multidisciplinairy guidelines for stroke (of the Dutch Heart Association, 2001) or according to the Dutch

guidelines for the treatment of people with Parkinson's disease (of the Royal Dutch Association for Physiotherapy (KNGF), 2004); in addition the treatment embedded as much mental training as possible. The patients from the mental practice group were taught how to use mental practice to improve motor performance by practicing skills and movements stepwise in thought.

The control group was also treated according to the best evidence in guidelines, but the mental practice part was replaced by home work (stroke) or relaxation (Parkinson's disease).

Assessment took place previous to the 6-week intervention, directly afterward and during a follow-up measure (at 6 months in the stroke study and at 3 months after the intervention was completed in the Parkinson's study).

These tests determined the subjective changes of the movement performance as judged by the therapist and by the patients separately on a Numeric Rating Scale (in the stroke trial) or a Visual Analogue Scale (in the Parkinson's trial). Several different objective motor tests were used to assess the changes in mobility, such as walking speed (10-m walking speed), arm function (motricity index), and the time needed to stand up from a chair, 3 m of walk, turn walk back, and be seated again (timed up and go).

What was the global outcome in the stroke trial on a group level?

Both groups had had a comparable amount of therapy. Some patients from the mental practice group were treated a little over average at the beginning of the trial to learn the technique. Both groups showed recovery. Most progress was seen at the first measuring moment directly after the 6-week intervention period. However, the differences between the groups were small. In this study, we therefore could not confirm quicker or better recovery of the mental practice group in patients in the subacute phase of recovery, at 6 weeks, nor at follow-up at 6 months.

What was the global outcome in the Parkinson's trial on a group level?

Both groups had had a similar amount of therapy and approximately had practiced the same amount unguided. Results from the movement tests showed that both groups had improved a lot, both at 6 weeks (postintervention) and 3 months (follow-up). There was no significant difference in results between the groups.

The participants in this trial, who were in the early stages of the disease, did reveal a positive trend in favor of the mental practice intervention (< Hoehn and Yahr Scale 3). These are the patients who do experience problems while moving, but are not dependent on others or (walking) aids. Perhaps, this is a subgroup within the Parkinson's population that might benefit more from mental practice than patients in the higher stages of the disease. More research into this aspect is needed.

What were the effects on an individual level and what were the experiences of the patients suffering from stroke or with Parkinson's disease with regard to the mental practice use?

To gain more insight into the experiences of patients regarding mental practice, we performed a process evaluation. As part of this process evaluation, individual and focus group interviews were taken. Among other topics, we asked patients why they used imagery, how they used it, whether they liked it, and whether they perceived any (subjective) benefits from mental practice.

Patients were taught to use mental practice to influence their motor performance and were therefore instructed to step-wise practice the movements in their mind. However, patients from the stroke trial seemed to do something as well, they seemed to focus on the emotional level of movement. Aspects such as security, not being afraid, were repeatedly reported in the interviews. Apart from this emotional aspect, the majority of the interviewed patients with stroke seemed to also motivate themselves for therapy through imagery. In contrast to the stroke population, participants with Parkinson's disease seemed to fully focus on the movement; the use of mental practice to change emotion, cognition, and or motivation was rarely mentioned in the interviews.

There therefore seems to be a population-specific aspect in the use of mental practice as an additional therapy form, which needs to be considered and taken into account when used in different neurological populations.

Why did we not find effects on a group level?

In contrast to the majority of publication on the imagery subject, we did not find any positive effects of mental practice with regard to motor performance. Therapy as usual seems to be as good as embedded mental practice. Several explanations can be given for this, some of which are within and some outside of the research protocol.

A possible reason within the research protocol could be that the sample sizes were too small (too little power) to detect an existing difference or that we perhaps did not select the most eligible patients; patients who will benefit the most. In addition, it could be that the difference between the control and experimental intervention was not big enough (contrast in the Parkinson's study) or perhaps the additional effect was there, but not measurable within the large amount of natural recovery (stroke study).

Maybe, we chose the wrong measuring instruments. If perhaps measures on the domain of cognition and emotion had been used, we would have established advantages of mental practice.

On the basis of results of systematic reviews on the subject, one might get the impression that mental practice helps in every patient with stroke (young, old, subacute and chronic stage of recovery) and that every mental practice intervention simply works. It is important to realize that most (positive) published studies have small sample sizes and the trials were conducted under relatively optimal circumstances. The studies presented above are small as well, but are presently the single largest (stroke) and largest (Parkinson's) ones. They are also the only multicenter trials, which means that patients were recruited at different locations. This approach resembles reality more, but also contains more 'noise', which makes the determination of possible existing effects more difficult.

A possible reason outside the research protocol could be that (almost) only positive effects of mental practice are published in literature. Trials with a negative or neutral result are harder to publish (publication bias) and they therefore cannot be taken into account in systematic reviews.

Step 4: implementation

On the basis of the evidence in literature and the results of the described trials above, we do (not) recommend implementation of the used mental practice framework on a large scale in the therapy of either patients suffering from stroke in the subacute phase of recovery or in patients with Parkinson's disease.

What does this mean for future research?

A Dutch psychologist once wrote: 'We call something normal because it happens a lot, not because we understand it.' We believe the same accounts for movement imagery and mental practice and that it would be useful and helpful to study the phenomenon further.

The focus of future research should be on (Fig. 3):

Development:

(1) study underlying mechanisms of why mental practice works in some patients and does not in others (individually and disease related);
(2) predict who is able to perform and benefit from mental practice (selection and prognosis);
(3) assess whether mental practice interventions need to be adjusted to stage of motor recovery, complexity of the skill, and specific patient populations.

Feasibility and piloting:

(1) determining and evaluating clinical pathways to gain a more realistic view on recruitment;
(2) determine possible negative side effects of mental practice.

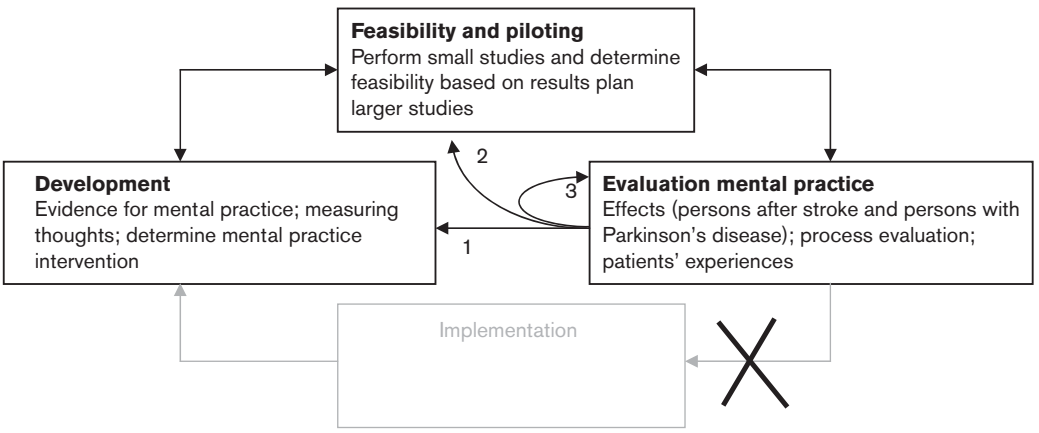
Evaluating:

(1) select the best measuring instruments to determine effects on different levels (cognition, emotion, and motor performance);
(2) make results from trials comparable;
(3) assess mental practice behavior through qualitative research;
(4) evaluate processes and cost effectiveness.

Conclusion

Research into fashionable interventions such as mental practice and movement imagery should take place early so that sufficient evidence reveals whether a therapy form is feasible and effective and for which patients it is useful. This research project showed that to research possible effects of a complex intervention in patient populations

Fig. 3



The four steps within the development and evaluation of complex interventions according to the model of het Medical Research Council (MRC, Craig *et al.*, 2008). Further research should focus on the first three steps. On the basis of this information, it can be determined whether implementation of mental practice interventions in the care of patients with a neurological disease is useful.

with complex pathologies in complex clinical pathways is not easy.

The MRC model is very useful for handling research questions at different methodological levels and to systematically research the topic of mental practice.

Although we found no effects in favor of mental practice on a physical level in our trials, we believe that it may help. Effects on physical functioning have been reported in literature as well as increased feeling of autonomy and patient-perceived outcomes related to motivation, cognition, and emotion. The latter results were also found in the trials discussed. At the end of this research project, new research questions were defined and placed within the first three steps of the MRC model. Future research is necessary to determine more realistically what mental practice might contribute to the rehabilitation of patients with neurological diseases and which expectations mental practice cannot fulfill. Results from future studies will determine whether mental practice should be implemented in routine care and if so, what the best way is to implement it.

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Conflicts of interest

All authors declare that they have no commercial or competing interest relevant to the subject of the manuscript. We certify that no party having a direct interest in the results of the research supporting this article has or will confer a benefit on us or on any organization with which we are associated.

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