Functional reorganisation of basic motor actions in Parkinson's disease
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Summary

Functional reorganisation of basic motor actions in Parkinson’s disease: problem analysis, development and evaluation of a compensatory strategy training

This thesis is the result of research aimed at developing an intervention to teach patients with Parkinson’s disease (PD patients) to perform basic motor actions more effectively. Earlier studies have suggested that limitations in basic motor actions such as turning in bed, rising from a chair or walking play a major role in disabled everyday functioning of PD patients. It could therefore be of great importance to develop an intervention that would specifically focus on these basic motor actions. In Chapter 1 this aim is formulated as the central research question. Answering it required resolving a number of sub-questions:

1) Are basic motor actions and related activities indeed particularly problematic and disabling for PD patients,
2) How can this be understood from scientific points of view with regard to neurology, motor control and biomechanics,
3) How can this knowledge be used to develop an intervention in which patients learn to perform basic motor actions more effectively, and
4) Can such an intervention be successfully applied in PD patients and positively affect their everyday functioning.

Before dealing with these questions, Chapter 2 starts with an introduction to Parkinson’s disease. The chapter contains a comprehensive view on the consequences of PD for motor functioning, cognitive functioning and mood. It provides a review of the early research that resulted in the studies of this thesis. Theoretical considerations on motor control and possibilities of motor learning in PD patients are also discussed. Further, current neurological and rehabilitation management is described, ending with a prelude to a compensatory intervention approach, advocated in this thesis.

Chapter 3 examines what the most problematic activities of daily living are, according to PD patients themselves. The results confirmed the assumptions on the importance of basic motor actions for ADL in PD. For the study, an extensive questionnaire (471 items) was developed, covering a broad range of daily activities. An indicative sample of the Dutch population of PD patients (N=44) still living at home returned adequately completed questionnaires. From the acquired data it became clear that activities related to locomotion and body transfers were most frequently indicated as being impaired and limiting daily functioning. Especially walking long distances (half a mile or more), rising from sit in various conditions, maintaining an upright position and bed-related actions (getting in and out of bed, turning and moving about) stood out. Another important category concerned the limitations in communication due to poor writing and impaired speech. Activities with regard to personal care (with the exception of buttoning garments, tying shoelaces, putting on socks, drying one’s back and clipping toenails) and other domestic activities were considered problematic less frequently. In Chapter 3 it is argued that interventions, expected to improve the ADL functioning of PD patients, should be directly aimed at the problematic activities themselves. In particular, the prominent problems in basic motor actions related to locomotion and transfers
deserve ample attention, as these are important determinants of physical independence and quality of life.

The study of Chapter 4 attempts to develop a method for such an intervention. The study focused on turning in bed and rising from a chair. In a first experiment these two basic actions were kinesiologically assessed in ten healthy young subjects (ages 20–30), ten healthy elderly subjects (ages 60–70) and ten PD patients. In healthy subjects, turning in bed and rising from a chair appeared to be complex motor tasks. Many distal and proximal movement parts can be discerned, executed sequentially and simultaneously, quickly, with proper tuning (correct muscle energising and relaxation) and without the need or even the possibility of complete conscious control. A fundamental involvement of axial motoricity by means of correctly regulated postural activity and maintenance of balance was demonstrated. The fact that all these characteristics are particularly affected in PD, as put forward in Chapter 2, made it understandable that basic motor actions such as rising from a chair, turning in bed and walking are particularly disturbed in PD.

In a second experiment, alternative movement strategies for turning and rising from a chair were developed. It was hypothesised that reorganisation of the way in which these actions are normally controlled (from automatic to consciously controlled) would enable PD patients to improve performance. This would also require reorganisation of their kinesiological structure. For these alternative strategies, sequentially arranged simple partial movements replaced the large complex movement patterns, each leading to a stable in-between position and with a logical and strict sequence. They were taught to ten, non-demented PD patients: three mildly affected, three moderately affected and four strongly affected. Individual training of six 1-hour sessions was set up to teach these new movement strategies. PD-specific cognitive deficits with regard to memory and regulation of attention were anticipated for in the training. After the training, patients of mild and moderate severity showed good results: they hardly made any errors in the execution of the learned strategies, which also led to better movement results. The strongly affected patients performed less successfully. Improvement was present but not sufficient.

The aim of the study as conducted in Chapter 5 was to find out whether such compensatory movement strategies could be implemented in a more comprehensive training programme and would lead to better ADL performance of PD patients. In a controlled study, an experimental group of 25 patients learned alternative movement strategies for chair-related actions (sitting down and getting up), walking-related actions (gait initiation/termination, turning while walking) and bed-related actions (getting in and out of bed and turning in bed). The experimental group was periodically retrained and followed for one year. Its performance was compared with that of a control group (N=13), which participated in a non-specific in-group exercise programme. Video analysis revealed that only the experimental group showed consistent and lasting improvements in performance. Rating scales and questionnaires provided additional evidence of these improvements and application in daily life.

When considering the results of the studies, the following conclusions with regard to the research questions can be drawn (Chapter 6). PD patients do experience most disabilities in activities related to locomotion and body transfers. Kinesiological analysis of these basic activities (or rather the basic motor actions they comprise) in normal subjects and knowledge regarding abnormal patterns and a delayed loss of the strategies are useful clues for patients can lead to the inadequate patterns. What these patterns and a next step would be the strategies are ultimately successful use of the strategies are performed strategies are available. The next step would be the strategies are available.
normal subjects and PD patients plus association of the findings with scientific knowledge did provide a better understanding of their special status. It also provided useful clues for how to improve these activities. The experiments proved that PD patients can learn alternative movement strategies by which they can compensate for the inadequate automatic generation and execution of the original movement patterns. What is required is a kinesiological simplification of the original movement patterns and a consciously controlled execution of the constituent parts, learned during a PD-specific training program that anticipates for cognitive deficits. When the strategies are periodically retrained, patients can maintain a high performance level over time (at least one year). Furthermore, both patients and partners report successful use in everyday situations.

Although the results of teaching PD patients compensatory movement strategies are promising, additional research is still necessary. The scope of the performed studies does not allow conclusions on prevention of early immobility, delayed loss of independence and preserved quality of life. In addition, the training of compensatory movement strategies was evaluated in an experimental situation. A next step would be to examine optimal implementation in current movement therapy practice. This may ultimately lead to the development of a practice of integrated neurological and rehabilitation treatment in which patients can be best treated. A framework for such a practice is suggested in Chapter 6.