Neurorehabilitation for Central Nervous System Disorders

Frans van der Brugge

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Preface

The purpose of this book is to demonstrate the commonalities in symptomatology in various central nervous system (CNS) disorders. Neurorehabilitation is thus placed in a broader perspective, as a result of which, the physiotherapy care for people with a CNS disorder becomes a specialism.

In my work as a physiotherapist, I discovered, when caring for people with a CNS disorder, the concept of NDT (*neurodevelopmental treatment*) was not *the* method, but *a* method. When it comes to physiotherapy care, there are many roads that lead to Rome. The trick is to follow the right road together with the patient. To be able to make that choice, you need to know about all the possibilities that are available to allow the patient with a CNS disorder to function in his immediate surroundings.

In the courses I give, I have noticed that it is not easy for physiotherapy professionals to regard neurorehabilitation as a single entity. Gradually during the course, this becomes clearer, and they discover that finding the commonalities between various CNS disorders and appropriate physiotherapy interventions has an added value. This has led me to believe that gathering all the information about «neurorehabilitation in CNS disorders» and turning it in a practical, concise book would be a good idea. I hope that this contributes to finding the most suitable physiotherapy intervention, with the purpose of allowing the patient to function better in his immediate surroundings.

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Acknowledgments

I wish to thank the Revant Revalidatiecentrum in Breda for the fact that I have been able to gain much in terms of knowledge and skills there over the last 14 years. In particular, I wish to thank Luc’t Jonck, Veronique van Voorthuysen, and Marco van Woensel. They contributed to the realization of this book.

I also wish to thank all patients whom I have had the privilege of treating in that period. I have learned a huge amount from them.

Introduction

We look on a global scale at the most frequently occurring CNS disorders, and these are cerebrovascular accident (CVA), Parkinson's disease, multiple sclerosis (MS), and dementia. In *Neurorehabilitation for Central Nervous System Disorders*, these four syndromes are described for the first time in a cohesive manner. Given the title of this book, neurorehabilitation should mean rehabilitation for *different* CNS disorders, and this requires insight in the specific nature of the pathologies concerned (▶ Chaps. 1, 2, 3, and 4). However, when examining various CNS disorders, you come to the conclusion that there are many commonalities. These are starting points from which to place neurorehabilitation in a broad perspective (▶ Chaps. 5, 6, and 7).

Before taking a look at neurorehabilitation, it is worthwhile to examine some of the history of caring for people with a CNS disorder. The best-known international treatment concept in recent decades that focused on a CNS disorder was undoubtedly the NDT concept (*neurodevelopmental treatment*). The concept was, as a whole, matched to the CNA patient. The influence of the NDT concept in recent decades on the treatment of CVA patients has been huge. The NDT concept formed the guiding principle for the treatment of CVA patients, not only in the Netherlands but also in many other countries, and still does so. The work of the Bobaths and Pat Davies (Davies 2001) was of great significance and offered many physiotherapists a guide in the complex symptomatology that follows from damage to the brain. The aims of the NDT concept were formulated as follows:

- Preventing abnormal postural and movement patterns
- Eliciting normal motor skills on the basis of normal tonicity
- Pursuing as great as possible independence and participation in society, with an optimum deployment of the hemiplegic side

Meanwhile, the following has become known about these aims:

1. The prevention of abnormal postural and movement patterns was not pursued within the NDT concept. The assumption was made that movement in the stereotypical patterns that had arisen would lead to an undesirable structural increase in tonicity. This appears not to have been a good approach. It has, in fact, been shown that with regard to the contraction patterns of the musculature, as measured by an electromyogram (EMG), no changes take place up to 6 months after the CVA (Otter et al. 2006). In spite of (or thanks to) this stability in the contraction patterns, progress was, however, measured in functional skills. These findings are very important, because the progress in terms of function gained in the past decades was mainly attributed to improvement in contraction patterns of the musculature (Davies 2001). This turned out not to be the case. One interpretation of these data could be that it is better to expend no effort on normalizing movement patterns. It is possibly better to invest in stabilizing movement patterns that have developed, by making use of these «abnormal» postural and movement patterns that have arisen. This leads to adaptive stability within a changed body, which results in people being able to function better in terms of activities of daily living (ADL).

2. The idea of attempting to invoke normal motor skills on the basis of a normal tonicity arose from the idea that the CVA patient shows motor skills that are comparable to those of a baby who is developing. However, we must not forget that a baby's brain is maturing. With the CVA patient, there is in fact a defect. Empirical evidence shows us that the vast majority of people with a CNS disorder move in stereotypical patterns. We can therefore ask ourselves whether it is realistic to pursue normal motor skills. Optimum independence of the patient must surely be the aim of the rehabilitation. The quality of the motor skills is indeed important, but is overshadowed by the degree of independence that can be achieved.
3. The goal of achieving as great as possible independence and participation in society, in which the hemiplegic side is integrated optimally, remains a key pursuit in the physiotherapy care of people with a CNS disorder.

Two out of three of the objectives of the NDT concept therefore can no longer be supported with the knowledge we now have. But what should we do now with the NDT concept and the techniques that have been developed, such as inhibiting, stimulating, facilitating, and guiding, which are intended to allow the patient to experience normal motor skills in order to be able to generalize himself in his own actions? The answer is: have insight into this concept when you opt for this sensorimotor *hands-on* learning strategy. It is *one* part of neurorehabilitation, and knowledge about it is certainly required.

Apart from this sensorimotor learning strategy, there are, however, many other motor learning strategies. Insight into this still seems to be an unexplored region within the physiotherapy care of people with a CNS disorder. Matching the motor learning strategy to the rehab patient or making a conscious choice for a particular motor learning strategy, taking account thereby of the neuropsychological function impairments, certainly appears to be something that is not done routinely in practice.

Physiotherapists generally have their own way of working. Matching the learning strategy to the patient's preferred way of learning can be many times more effective when practicing motor skills. Insight into motor learning processes and the various learning strategies can be helpful in this (► Chaps. 9 and 10).

When offering learning strategies, fatigue is known to be a restrictive factor. It is a frequently occurring symptom in CNS disorders (Hochstenbach and Mulder 1997) and is regarded by patients as one of the most restrictive factors in their general functioning. Treatment interventions to influence fatigue in CNS disorders are not (consciously) implemented within treatment protocols. Given the large impact that fatigue has on general functioning, consideration will be given in ► Chap. 8 to possible treatment interventions aimed at reducing the fatigue experienced.

This book enables you to view neurorehabilitation in a broader perspective. The intention of this book is not to provide a detailed perspective of conceptual models but, rather, to describe the symptomatology, to acknowledge the commonalities and many examples drawn from practice, and to contribute to generating insights into these theoretical conceptual models. As a consequence, you, as a physiotherapist, will be able to care for patients with the most common CNS disorders and aid them to achieve optimal functioning in terms of ADL.

Contents

About the Author

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has been teaching courses on neurorehabilitation in CNS disorders since 2010, both nationally and internationally; see ► www.neurorevalidatie-cna.nl. He has worked since 2008 as a physiotherapist and has been the owner, since 2011, of the private physiotherapy practice PLUK! fysiotherapie, which was founded in Breda. From 2004 to 2011, he was the content expert and coordinator of the master's course for geriatric therapist run by Avans+ in Breda. From 1998 to 2004, he worked as a lecturer on the physiotherapy course offered by Avans+ in Breda. From 1994 to 2007, he worked in the Revant Revalidatiecentrum Breda and specialized in neurology, in both adults and children.

Symptomatology in Practice After a CVA

F. van der Brugge, *Neurorehabilitation for Central Nervous System Disorders*,
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Summary

A CVA is a very serious and sudden occurrence. This is thus a specific symptom of this CNS disorder, in contrast to dementia, Parkinson's, and MS, which are characterized by their progressive course. Over the last few decades, the care for CVA patients has improved enormously, and much expertise has been gained in terms of insights into the impairments that result from a CVA. The experience thus gained can be transposed to the other CNS disorders described in this book. There are, namely, many commonalities, and this provides the opportunity to place neurorehabilitation in a broader perspective. This chapter lists the symptoms that may be an indicator for the occurrence of a CVA, which is followed by the description of the symptomatology after a cerebrovascular accident (CVA). Given that patients are permitted direct access to physiotherapy in the Netherlands, the physiotherapist must be able to recognize symptoms at an early stage. This chapter also examines the causes and risk factors of a CVA. When these are recognized, it is possible to take specific actions that reduce the chance of a CVA.

1.1 Introduction

A CVA is a very serious and sudden occurrence. Suddenly, from 1 s to the next, you may be paralyzed on one side, be aphasic, or feel that the world around you is going so fast that you can no longer make any sense of it. This is thus a specific symptom of this CNS disorder, in contrast to dementia, Parkinson's, and MS, which are characterized by their progressive course.

The care for CVA patients has improved enormously in recent decades, and much expertise has been gained relating to insights into the impairments that result from a CVA. The experience thus gained can be transposed to the other CNS disorders described in this book. There are, namely, many commonalities and this provides the opportunity to place neurorehabilitation in a broader perspective.

This chapter lists the symptoms that may be an indicator for the occurrence of a CVA, which is followed by the description of the symptomatology after a cerebrovascular accident (CVA). Given that patients are permitted to directly access physiotherapy in the Netherlands, the physiotherapist must be able to recognize symptoms at an early stage. This chapter also examines the causes and risk factors of a CVA. When these are recognized, it is possible to take specific actions that reduce the chance of a CVA.

1.2 Early Identification, Causes, and Risk Factors

Studies have shown that people who experience a CVA have often had TIAs (*transient ischemic attacks*) previously. If you recognize the acute symptoms and any phenomena that occur with a TIA, you can decide whether to refer the patient for more extensive tests. Early identification of symptoms according to the FAST system is of great relevance:

F	Face	Is one side of the face drooping?
A	Arm	Can the patient keep both arms stretched out?
S	Speech	Is the patient's speech still clear and coherent?
T	Time	Starting time of the symptoms?

▣ **Table 1.1** Acute symptoms and possible symptoms of a TIA that may occur

Acute symptoms	Possible symptoms that may occur
Dizziness and/or balance impairments	Unilateral paralysis
Severe headache	Heightened reflexes on the paretic side
Frequently blue, swollen face	Unilateral sensory impairments
Loss of consciousness	Unilateral visual impairments
Slow and snoring breathing	Swallowing impairments
Possibly wide, light-insensitive pupils	Possible aphasia (word-finding problems)

▣ Table 1.1 Lists the symptoms to which one must be alert.

When acute symptoms and phenomena that occur are identified early, thrombolysis can be performed within 4.5 h of the CVA in the hospital. This is done where there is a cerebral infarction caused by a blood clot. This can clearly reduce the severity of the permanent sequelae. If it is not possible to take action within this time frame, rapid admission to the stroke unit is then indicated, so that intensive rehabilitation is then possible.

A cerebrovascular accident can have various causes:

1. Cerebral infarction (80%)
2. Cerebral hemorrhage (including subarachnoidal hemorrhages) (20%)

Knowing the causes that can lead to CVA offers opportunities to influence these factors in a positive manner. In the preventive sense, it is therefore important to know the causes (C), as well as the risk factors (RF). Risk factors can, namely, lead to a cause (see ▣ Table 1.2).

▣ **Table 1.2** Cerebral infarction, cerebral hemorrhage, and subarachnoidal hemorrhage: causes and risk factors

Cerebral infarction	Cerebral hemorrhage	Subarachnoidal hemorrhage
Arteriosclerosis (C)	Arteriosclerosis (C)	Arteriovenous malformation (C)
Space – occupying lesion (C)	Space – occupying lesion (C)	Aneurysm (C)
High cholesterol (RF)	Aneurysm (C)	High blood pressure (RF)
Cardiac arrhythmias (RF)	Use of anticoagulants (RF)	In combination with use of oral contraceptives (RF)
Operation (RF)	Congenital bleeding disorders (RF)	
Diabetes mellitus (RF)	Diabetes mellitus (RF)	
High blood pressure (RF)	High blood pressure (RF)	

1.3 Symptomatology After a CVA

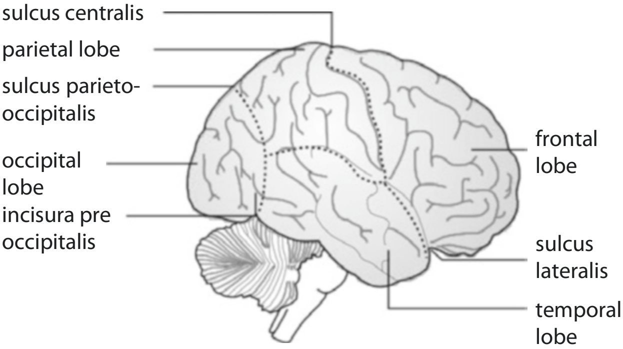
The sequelae as a result of a cerebral infarction or cerebral hemorrhage are directly related to the scope and the locality of the lesion. The sequelae are, for each individual, very diverse in nature. The following primary impairments can occur as a result of a lesion in the brain:

1. Sensorimotor impairments
2. Communicative impairments
3. Cognitive and behavioral changes
4. Imbalance in the workload and capacity model as a result of socio-emotional problems

◘ Figure 1.1 shows the neural organization of our brain and provides an insight into the relation between the localization of the lesion on the one hand and the symptomatology that occurs as a consequence of that lesion on the other hand.

◘ Table 1.3 provides a simplistic view of the neural organization of our brain. It gives an insight into the relation between the localization of the lesion on the one hand and the symptomatology that occurs as a result of that lesion on the other hand.

◘ **Fig. 1.1** Cerebral lobes, cerebellum, and brain stem



◘ **Table 1.3** Locality of lesion and possible symptomatology

Locality of lesion	Possible symptomatology
Frontal lobe	Ability to think, executive functions, behavior, visual center, part of the speech (Broca's aphasia)
Occipital lobe	Processing of visual stimuli, face perception
Parietal lobe	Spatial organization, motor skills, and sensation
Brain stem	Vital functions, such as blood pressure, respiration, temperature, etc.
Cerebellum	Movement sequences (sequence), tonicity regulation, and coordination of movement
Temporal lobe	Memory, concentration, taste, and a part of the speech (Wernicke)
Limbic system	See ► Sect. 8.4

We can see that a lesion in the cerebellum would therefore not cause any loss of function; it would mainly cause a loss of coordination. This has to do with the neural organization in the brain, and it is good to be aware of this so that the observed symptomatology can be related to the lesion in the brain.

The primary impairments named previously, which can occur as a result of a CVA, are discussed below. Although these impairments seldom occur in isolation and they do influence each other, it is necessary to describe each of them independently. This provides clarity and offers ways of unraveling, to some extent, the complexity of the symptoms.

1.4 Sensorimotor Impairments

The term «sensorimotor» is a combination of sensory and motor. Sensorimotor impairments lead to diminished motor function. This term indicates the close link between the sensory system and motor skills, also known as sensorimotor integration.

The most frequent sensorimotor phenomena as a result of a CVA are spastic hemiparesis and loss of sensation. These are expressed on the heterolateral side of where the lesion occurred. In other words, an infarction in the linker hemisphere causes a hemiparesis on the right side of the body. Depending on the localization, the face, arm, leg, and trunk can be involved (◘ Fig. 1.2).

It is known that proximally the extremities are bilaterally innervated from the corticospinal tracts (Ghez 1991) and that we find unilateral innervation more distally in the

◘ **Fig. 1.2** Right-sided spastic paresis resulting from left-hemisphere infarction extremities. Because of this, distally there is reduced spare neural capacity in respect of plasticity, and the CVA patient has less chance of making a full recovery.

The unilateral innervation also explains why substantial loss of motor function of the wrist and finger extenders and of the foot flexors occurs so frequently in CVA patients.

In most CVA patients, no substantial loss of function is observed in the muscles of the trunk. This is because these fundamental muscle groups are bilaterally innervated. This is essential, considering that these muscle groups must function as a good «suspension system» for the organs and also fulfill a supporting function for respiration. There is, however, frequently a reduced adaptive capacity of the trunk musculature (see below under «Reduced Adaptive Capacity of the Trunk»).

1.4.1 Primary Motor Impairments

When a CVA has occurred, primary and secondary motor symptoms can be distinguished. The primary motor symptoms can be subdivided on the basis of tonicity into positive and negative symptoms.

Positive Symptoms

▪ Spasticity

Central muscle-tone dysregulation (CMD) is characteristic of a CNS disorder. Spasticity is a manifestation of muscle-tone dysregulation that we frequently see as a result of a CVA. There is spasticity when increased resistance is felt with passive motion in combination with heightened myotatic reflex activity (Lance 1980).

Spasticity is negatively influenced by fatigue, pain, speed, and stress. The spasticity will be more prominently present under the influence of these stressors, and functioning will be negatively affected.

Spasticity can be measured using the scales developed by Ashworth and de Tardieu. The *Ashworth Scale* is a test whereby the tone is manually tested in a passive manner.

The test does not take account of the relation between the heightened tonicity on the one hand and the starting position of the patient and the related, associated muscles reactions on the other side. This causes limitations with regard to the reliability of the test. A five-point scale is used for the test:

1. Tonicity not heightened.
2. Slightly heightened tone: a catch followed by a minimum resistance during the rest of the range of motion (ROM).
3. Moderately heightened tone: a clear resistance during the ROM.
4. Substantially heightened tone: considerable resistance and passive movement are difficult.
5. Rigidity: passive repositioning is virtually impossible (◘ Fig. 1.3).

With the *Tardieu Scale*, the stretch velocity is measured in relation to the muscular response (also called catch). In this way, the dynamic component of the muscle length is determined. R1 is the catch that is felt with rapid movement, and R2 is the catch felt with slow movement (see ► Example from Practice 1.1). This clinimetrical finding is clinically relevant, because the velocity-dependent effect can be included in the test. With regard to spasticity, it is known that velocity can have a negative influence on the degree of spasticity.

◘ **Fig. 1.3** Substantially heightened muscle tone: considerable resistance and passive movement is difficult

Example from Practice 1.1

Luke is given an injection with Botox in connection with the high tension in his calf muscles. To collect objective data, among other things, the degree of spasticity is determined using the Tardieu Scale. When the foot is slowly repositioned to dorsal flexion, we achieve 5° of dorsal flexion (=R2).

When the velocity-dependent component is added (the foot is rapidly moved into dorsal flexion), the foot does not pass the neutral position, but the catch occurs at 5° of plantar flexion (=R1). The difference between R1 and R2 is the degree of spasticity, thus in this case 10°.

Spasticity occurs frequently in stereotypical patterns. To be able to recognize these, here is a list of how these are often manifested in the extremities after a CVA.

Upper extremity:

1. Shoulder: retraction, endorotation, and depression
2. Elbow: flexion and pronation
3. Pulse: palmar flexion and ulnar deviation
4. Fingers: flexion
5. Thumb: adduction and flexion (◘ Fig. 1.4)

Lower extremity:

1. Hip: retraction, endorotation, and elevation
2. Knee: extension and endorotation
3. Ankle: plantar flexion and inversion
4. Toes: clawing or flexion (◘ Fig. 1.5)

Fig. 1.4 Spastic pattern – upper extremity

Fig. 1.5 Spastic pattern – lower extremity

Insight into these spastic patterns not only makes it easier to recognize pathological motor skills, but it offers also starting points for physiotherapy interventions if you opt for the «feeling» relearning of motor skills (see ► Chap. 10).

Hyperreflexia

Hyperreflexia is a heightened myotatic activity that can be diagnosed by evoking the reflexes. The most commonly used tests are the Achilles tendon reflex, the knee jerk reflex, and the biceps reflex of the arm. In some cases this heightened myotatic activity is so prominently present that you can observe the heightened reflex when, for instance, you tap someone on the thigh. This hyper-myotatic activity leads to uncontrolled tensing of all muscle fibers. Because of this, no adequate response can take place when, for example, an unexpected situation occurs.

Example from Practice 1.2

Mrs. M. has suffered an infarction in her left hemisphere. Dissociated movement is very difficult for her. During the gait analysis, a circumduction of the leg was observed during the swing phase. The foot is placed in midstance on landing.

There is some dissociation, but as soon as something unexpected happens (she is, e.g., overtaken by someone or there is a strange sound that makes her jump), her whole right leg then stiffens. An examination reveals that, among other things, there is hyperreflexia in her right leg. In her ADL this regularly bothers her. She jumps when, for example, the front doorbell rings or the telephone. The consequence is that she does not have her right leg under control and this results in losing her balance. This has caused her to fall once.

Attention is paid to this during treatment. Walking is practiced in a quiet space, and the course she has to walk is made increasingly more difficult. This is expanded into an environment with more stimuli. Finally situations are practiced by means of badminton. Her balance was evaluated with the Berg Balance Scale.

Hypertonia

Hypertonia is a heightened basic muscle tension in the musculature without the presence of heightened resistance with passive movement and a heightened myotatic reflex activity (e.g., an increase of the muscle tone in the musculus trapezius descendens with stress at work). In practice hypertonia and spasticity are regarded as synonyms; however this is not therefore correct.

The possibility of influencing hypertonia by means of physiotherapy intervention is good, in contrast to spasticity.

Rigidity

Rigidity is a form of central muscle-tone dysregulation (CMD), which manifests in the form of a heightened tone in both the agonist and the antagonist. This form of tonic dysregulation is seen with subcortical lesions. The basal ganglia also lie in the subcortical structures. This is the reason that rigidity is also the term used for the Parkinson’s patient. A typical consequence of rigidity is a slowed and reduced flexibility of the motor skills.

Clonus

Clonus is a series of rapid involuntary rhythmic muscle contractions, evoked by a rapid stretching of the musculature (e.g., the calf muscle). What then occurs is a slow tensing and relaxing in the muscles that may or may not extinguish.

Example from Practice 1.3

Mr. F. has a partial spinal cord injury and is hindered by substantial clonus. He indicates that it plays up when he is going up- or downstairs but especially when climbing. When he puts his foot down, his foot begins to shake, giving him the sensation that he is being pushed backward.

On analyzing him going up- and downstairs, we see the clonus is caused by the weight on the ball of his foot. When the weight is shifted to the front, you first get a dorsal flexion in the foot. This creates pressure on the ball of the foot and stretches the calf muscles. These factors provoke the clonus.

The presence of the clonus cannot be influenced, so a strategy has to be found that reduces the extent of the clonus. The choice was to place the whole foot on the next step. This reduces the capacity for dorsal flexion in the foot. There is then less pull on the Achilles tendon and the clonus is thus less provoked. Since then, using the stairs is no longer a cause for anxiety.

■ Disinhibition of the Tonic Reflexes

Asymmetrical tonic neck reflex (ATNR). If the ATNR, then when the neck is rotated to the right, the left arm bends and the right arm extends. With rotation to the left in the C-spine, the left arm extends and the right arm bends.

Symmetrical tonic neck reflex neck reflex (STNR). If the STNR is positive, there is an increase in tone in the extremities when there is flexion or extension in the neck. With flexion in the neck, you see flexion in the arms and extension in the legs. If there is hyperextension in the neck, you see extension in the arms and flexion in the legs.

Example from Practice 1.4

Mrs. J. is in the hospital following an infarction in the left hemisphere. The CVA occurred 8 days ago. She is being well looked after; the nursing staff regularly place some pillows under her head. She has paresis on the right side and given that she is right-handed, she is already experiencing functional problems. For that reason she is doing her exercises well and regularly doing exercises herself.

She cannot extend her right arm. She finds that strange, because when the physiotherapist is there, she can extend her arm. The only thing he does is take away a couple of the pillows from under her head!

Positive support response With the positive support response, hyperextension of the leg occurs when the ball of the foot is stimulated. Just like in ► Example from Practice 1.3, the ball of the foot can become stimulated such that an increase of tone occurs in the extensors of the leg.

Crossed extension reflex When a crossed extension reflex is present, an increase in extension tone is observed in the hemiplegic leg when the unaffected leg is bent at the knee and hip. This can be of influence, for instance, when caring for the patient in bed. To prevent this and to make nursing the patient easier, the affected leg should be bent first, so that the increase in extension tone cannot occur in this leg.

Example from Practice 1.5

The nurse sees that the physiotherapist can bend a patient's paretic leg very easily while the patient is lying in bed. She herself always has difficulty doing that when caring for the patient. She notices that the physiotherapist always bends the affected leg first. She asks why he does that. After his explanation, she tries it out herself and finds that the paretic leg bends more easily. She implements this into the nursing care and notes it in the care plan. Everyone tries to apply this consistently and otherwise the patient reminds them of it. As from then, nursing the patient is a bit easier.

Negative Symptoms

Hypotonia

Hypotonia means that there is reduced tension in the musculature. Normal tone is defined as a slight constant tension in healthy muscles.

Example from Practice 1.6

It is exactly 8 weeks since Mrs. H. suffered a cerebral infarction in her right hemisphere. She has been told that many people in the early stages have a floppy arm. Gradually more tension will come back to the muscles. This has unfortunately still not been the case for her, while she has heard from other (and also seen for herself) that activity has returned to the arm. Mrs. Van H. can still do nothing with her arms; it is floppy, feels very heavy, pulls on her shoulder, and is always dangling in the way.

The physiotherapist looked at her in amazement after she asked: «When I am going to be able to do something with it?» She tells that the chances are high; there will be absolutely no return of activity in the arm and tells her about the Heart Foundation's guidelines.

But how could the patient know that? Perhaps she needs more time than others.

Hyporeflexia

When there is hyporeflexia, no reaction can be elicited when the reflexes are tested.

Paresis

Paresis is a partial paralysis, as a result of which there is a clearly observable weakness of the musculature. On inspection you see noticeable atrophy, and when a movement is started, you see a reduction in the quality of the movement. With hemiparesis there is, moreover, no total paralysis of one side of the body. If that is the case, this is called a paralysis.

Muscle Weakness and Loss of Random Movements

Studies have shown that in both spastic and paretic muscle tissue, there is an actual loss of muscle strength (Kwakkel 1995a). As a result of the CVA, there is a loss in the recruitment of *fast-twitch* (type 2) muscle fibers. Consequently an imbalance occurs between the *slow-twitch* (type 1) and the *fast-twitch* fibers, and thus less strength can be generated.

Loss of muscle strength in spastic muscle tissue can have a variety of causes. These can be categorized as *reduced output* paresis and *subtraction* paresis:

- With reduced output paresis, it is assumed, because of a reduction in central control, that a reduced recruitment of muscle fibers takes place. This then results in loss of muscle strength.

- With subtraction paresis, it is assumed that increased tension of the antagonist is responsible for the inability of the agonist to function. This apparent loss of muscle strength was the idea behind NDT. For this reason, inhibiting techniques were applied, after which the agonist was enabled to provide normal motor skills. Research however indicates that there is a real loss of muscle strength in the agonist (Kwakkel 1995a) and that naturally has consequences for the possible physiotherapy interventions (► Chap. 7).

Example from Practice 1.7

«I have to have a gait analysis,» Harriet tells the class. «They're going to see whether I'm going to have an injection with Botox or not.»

The reason for the gait analysis is to examine whether Harriet has the ability to tense the musculus tibialis anterior. A second reason is to measure the tension in the musculus triceps surae. This measurement has been already done on many children, and because of this there are standard values available. They use EMG and video recording for the analysis.

With sufficient ability to tense the *m. tibialis* anterior, there is a subtraction paresis. Injection of the m. triceps surae with Botox can be an effective intervention, because it is assumed that this spastic antagonist prevents the tibialis anterior functioning. By artificially paralyzing the triceps surae, it will be possible for Harriet to train the foot flexors.

That was a different matter a couple of years ago. Then, she stretched the calf muscles until they were relaxed, and then she had to exercise the other muscles by means of all sorts of balance exercises. Now she has 3 months to do that – after that the injection is no longer effective.

The subdivision of the primary motor symptoms on the basis of the primary motor symptoms on the basis of muscle tone into positive and negative symptoms is schematically shown in ◘ Table. 1.4.

Reduced Adaptive Capacity of the Trunk

Adaptive capacity means that the trunk in various situations with diverse exogenic disruptions can adequately maintain balance. It is not the case that the adaptive capacity of the trunk is vital in order to function optimally, but as Johan Cruijff said, «If you are at the top

◘ **Table 1.4** Primary motor symptoms: positive and negative symptoms

Positive symptoms	Negative symptoms
Spasticity	Hypotonia
Hyperreflexia	Hyporeflexia
Hypertonia	Paresis
Rigidity	Muscle weakness
Clonus	
Disinhibition of tonic reflexes	

(read here: motor skills ceiling) and you want to improve, then it is about training the details.» Whether it concerns anticipating the course of the game or the adaptive capacity of the trunk, you must be able to react adequately in all situations, and then therefore it is about the details.

The function of the trunk includes reacting adaptively to movements elsewhere in the body, and this must be stimulated as much as possible. It is thus not necessary for trunk balance to be optimal before starting, for example, walking or cycling.

The adaptive capacity of the trunk also contributes to developing more activity in, for example, the hemiplegic arm. Davies and Raadsen (1992) described in detail how the trunk can be trained as well as possible. Optimal training of the trunk is reflected in improvements in the extremities. ► Examples from Practice 1.8 and 1.9 are two examples in which the influence of the trunk on the extremities is illustrated.

Example from Practice 1.8

Mr. P., 56 years old, has suffered an infarction in the left hemisphere that caused a spastic hemiparesis of the right side. Amnesic aphasia was observed in the acute and subacute phase, which has gradually improved in the post-acute phase.

During the first weeks of rehabilitation, Mr. P. was wheelchair bound for larger distances in the clinic, but over the course of time, his strength has improved, and he is able to walk about independently and safely with the aid of an ankle-foot orthotic (AFO). He is getting increasingly better at formulating things in words, and he is, once again, functioning cognitively at the premorbid level.

Mr. P’s nature is positive in the sense that he is always prepared to commit himself 100% in order to achieve progress step by step in his general functioning. After completing the outpatient phase, he is able to walk unlimited on any type of terrain, and he is able to cycle again, despite the spastic paresis of his right arm. He can get around, but that’s pretty much where it stops. Dissociated movement is not possible.

When reformulating his request for help, his stated goal is to gain improvements in respect of the arm so that it can be better used in ADL.

The following measurement tools are used: the Motricity Index and the visual analogue scale (VAS). On the VAS (with a scale ranging from 0 to 10), he scores 5.5 for the question: «How satisfied are you now with the arm?» (0 = absolutely not, 10 = very satisfied).

The therapy consists of training the adaptive capacity of the trunk. The idea behind this is as follows: As a result of the cerebral infarction, it is not only the extremities that are affected but also, of course, the abdominal muscles. Given that these are connected left and right to each other by the fibrous linea alba, we can say that there is a bilateral reduction of function in the abdominal musculature. Other puncta fixa (fixed points) of the abdominal musculature are the ribs, to which the *m. serratus* anterior attaches. One consequence of the weakness in the abdominal musculature is therefore a less stable insertion point for the *m. serratus* anterior, the result being active insufficiency of this muscle.

Mr. P. functions, given his possibilities, at a high level. That is the reason for influencing in a detailed manner the adaptive capacity of the trunk thereby bringing about an improvement in the functioning of the upper extremity (UE).

After 10 weeks of training at a frequency of twice a week, the Motricity Index showed no progress (at this point we may naturally question whether the Motricity Index is responsive enough to measure small changes); on the other hand, the VAS went from 55% to 75%. Mr. P. indicates that he has the feeling that it is easier to make use of his arm, including when dressing and undressing, and when eating, he is better able to use his arm as a *helping hand*. Dissociated movement remains very difficult.

Example from Practice 1.9

Mrs. B. has suffered a CVA in the right hemisphere. She is 46 years old and is employed as a hairdresser. As a result of the CVA, she has a hemiparesis on the left side, which is characterized by a reasonable selectivity of movement being present proximally in both the upper and lower extremity. This is reduced distally at the periphery. Because of this she needs to use an AFO for walking longer distances.

There are typical right hemispheric neuropsychological function impairments, such as a reduced awareness of illness (anosognosia), impulsive actions, and much talking but difficulty in getting *to the point*.

Her request for help is to be able to resume her employment. It is important in this respect to know that she is right-handed and uses that hand to do the cutting. The left hand must be able to be used as the helping hand.

Tests have shown, among other things, that there is a substantial hypertonia in the lumbar erector trunk (LET), but that is very easy to inhibit. However, while doing standing tasks, this hypertonia in the LET increases again, as a result of which the abdominal musculature is, as it were, sidelined. Origin and insertion lie more distant from each other and are, as a result, actively insufficient. This is called a pseudoparalysis.

The goal of the treatment is after inhibition to train the adaptability of the trunk, so that an improvement of the abdominal musculature would occur. As a result of this, on the one hand, there will be a better punctum fixum for the musculature that is attached to the ribs (including the *m. serratus* anterior and m. latissimus dorsi) and consequently more stability around the shoulder joint. On the other hand, the abdominal muscles, when their function is improved, will be better able to resist the hypertonia of the LET. In this case, this improved stability is able to contribute in an improved function distally in the periphery, as a result of which the left arm can be better used as helping hand.

Treatment takes place over 10 weeks at a frequency of initially three times per week (4 weeks) and afterward twice a week. The treatment is evaluated using the Motricity Index. Although the patient shows clear progress on the MI and the left hand can also actually function better as helping hand, the request for help is not achieved in the end.

One possible cause of this is that burden and resilience are not in balance. The patient indicates that she suffers a lot from fatigue, and as a result of this fatigue, the function of her left hand is poorer. In addition, cutting hair and talking at the same time are no longer something she can do automatically – it takes a lot of effort for her to do that.

1.4.2 Secondary Motor Symptoms

The secondary motor impairments are an indirect consequence of the CVA. You could also say that they are a direct consequence of the primary impairments of the CVA. The following secondary impairments can be present:

1. Reduced aim and balance reactions when sitting and standing as a result of the muscle-tone dysregulation and loss of muscle strength that has occurred. This can thus cause problems with general balance.
2. Reduced respiratory capacity as a consequence of a weakened abdominal musculature. The CVA causes a weakening of the abdominal musculature not only on the hemiplegic side. Because of the attachment of the abdominal muscles in a non-bone structure (linea alba), there is on one side no longer a punctum fixum due to

weakening. Because of this, the musculature on the other side will obviously also lose function. The abdomen muscles will weaken as a whole and as a result play a less supporting role in respiration. Other functions of the abdominal muscles are voice production and developing strength in order to be able to cough properly. With CVA patients who are bedridden, when there is weakening of the abdominal musculature, there is a serious risk of them developing pneumonia.

3. Reduced stamina as a result of reduced respiratory capacity and a reduced action radius. As a result of the primary reduced strength caused by the CVA, a reduction of activities occurs. Because of this, general stamina will decrease resulting in a further loss of muscle strength. The consequence is that the patient will undertake even fewer activities and thus ends up in a vicious circle.
4. Altered viscoelastic properties in the musculature, as a result of which muscle stiffness and contractures can occur (see ► Chap. 6). Biomechanical changes can occur (Kwakkel 1995a) that are accompanied by loss of strength. After all more than half the length of the muscle needs to be used to bring about optimal strength generation. The maintenance of the muscle length is the starting point for the physiotherapy intervention.

1.4.3 Sensory Impairments

The sensory system consists of sensors that pick up and translate information. Sensors are specialized organs at the ends of afferent fibers. They are sensitive to certain stimuli, such as mechanical, thermal, chemical, etc.

Every sensor translates the stimulus into a series of impulses that are carried via the afferent nerve fibers to the central nervous system. The afferent nerve fibers can lead into the spinal cord, the brain stem, or the brain directly (nervus opticus = sight, nervus olfactorius = smell) and deliver their information at those points. Information is then sent back via efferent neurons, which then affects the control of motor skills or behavior.

Three main groups of sensors can be distinguished according to their localization:

1. *External sensors* are sensitive to stimuli from the surroundings. They are in or on the surface of the body and are represented by smell, vision, hearing, taste, and feeling. Exteroceptive sensation is subdivided into the gnostic, recognizing sensation (such as vibration, discriminatory sensation, and proprioception) and the vital sensation. This is the warning-type sensation such as pain, heat, strong pressure, and itch.
2. *Proprioceptive sensory organs* can be found in the movement apparatus (muscles, ligaments, and joints) and give information about the position of the joints. They are sensitive to mechanical stimuli, such as an increased tension in the musculature, length, and acceleration.
3. *Internal sensory nerves* can be found in the internal bodies, for example, pulmonary stretch receptors in the lungs.

Motor skills and thus movement lead to stimulation of these sensory nerves, and they in turn pass on information that is used to control movements and to activate new motor activity. This is called feedback. This can be divided into:

- Re-afferent information: the information is the consequence of the person's own motor skills (intrinsic feedback).
- Ex-afferent information: the stimuli coming from outside are registered (extrinsic feedback).

The interaction between the sensory system and motor skills is called sensorimotor integration. Sensorimotor integration takes place at several levels within the central nervous system and plays a very prominent role at the conscious and especially unconscious (re) learning skills and the implementation of actions. The sensorimotor integration actually gives constant feedback about the activity that one is doing. Without feedback one cannot learn (see ► Chap. 10).

Example from Practice 1.10

Keith plays tennis at a high level and hits the ball with a lot of feeling over the net. He knows precisely how he has hit the ball. He therefore knows what the ball is going to do on the other side of the net and where it will land (re-afferent information).

This stroke is part of the progression to winning a point. For this reason he starts to run toward the net so as to win the point. However he sees from the corner of his eye that his opponent is managing to do something impossible: he's trying to hit the ball back over Keith with a backhand. Keith has however noticed this (ex-afferent information) and does not run to the net but stays still. Because of this, he is easily able to smash the ball and win the point.

Sensory impairments can occur as the consequence of a brain injury where the gyrus postcentralis (primary somatosensory cortex) or the ganglia that are projected onto it have been damaged. The consequence is a loss, a reduction, or a multiplication of the perception of stimuli.

Just like with the motor impairment resulting from a CVA, here too, we find positive and negative symptoms.

Positive Symptoms

We distinguish:

- Hyperesthesia: elevated perception upon touch.
- Dysesthesia: spontaneous or evoked abnormal unpleasant sensations.
- Synesthesia: modalities are confused (touch is, e.g., experienced as heat).
- Allesthesia: the stimulus is felt in a different place than where it is given.

Negative Symptoms

We distinguish:

- Hypoesthesia with respect to exterocepsis
- Hypoesthesia with respect to propriocepsis
- Extinction

▪ Hypoesthesia with Respect to the Exterocepsis

Hypoesthesia can result in objects not being recognized or not being recognized properly when felt or the coordinated fine motor skills being impaired. This can lead to reduced use of the affected extremity. The gross motor skills can also become impaired, for example, dragging the foot over the ground, stumbling over edges, problems with walking in the dark, etc. With loss of the surface sensation, the risk of injuries is high.

- **Hypoesthesia with Respect to the Propriocepsis**

Example from Practice 1.11

Mr. D. has suffered an infarction in the right hemisphere, and one of the sensorimotor impairments he has suffered is a total loss of the propriocepsis of the left arm. When he is sitting at the table, he regularly knocks things over, his arm hangs down beside the table, and to make things worse, he wakes up in a panic at night because he has lost his arm. When he puts the light on, he fortunately sees it lying there.

He has taught himself that if he is going to use his left arm, he should always check this visually. Another strategy is that he regularly rubs the hemiplegic arm with his non-affected arm. This provides him with information about where the arm is and this reassures him.

- **Extinction**

Extinction means that when only the hemiplegic side is tested on surface sensation, the patient scores adequately. However, when both sides are tested, the non-affected dominates, and stimuli are no longer felt on the hemiplegic side.

In ► Chap. 6 a distinction is made between spinothalamic ganglia and spinocerebellar ganglia on the basis of investigative tests. When testing the sensation, what the person being tested indicates is taken as the value. This is in contrast to, for example, testing muscle strength, where the value is noted that is felt by the person conducting the test.

It is not easy to develop good measurement instruments that are aimed at adequately mapping out the level of loss of sensation. This therefore makes evaluating the impact of the interventions difficult.

Box 1.1 Influence of Smell on Behavior

Today there was a report in the newspaper that at a police station in Rotterdam, they have experimented with the influence of smell on behavior. They spread an orange fragrance in the prisoners' cells. This fragrance enters the brain directly via the n. olfactorius and has an influence on the limbic system, which regulates behavior and emotions.

The impact of the orange fragrance was that the behavior of the prisoners became more tranquil and less aggressive. The experiment is being repeated in other large cities in the Netherlands. Perhaps it will be used in the future on psychogeriatric wards of nursing homes to reduce the nocturnal unrest of dementia patients.

1.4.4 Recovery from Sensorimotor Impairments

According to the Royal Dutch Society for Physical Therapy (KNGF) guidelines, the following division can be roughly made with regard to the time phases that follow the CVA:

1. Acute phase: week 1
2. Subacute phase: week 2 to week 4
3. Post-acute phase: week 5 up to and including month 6
4. Chronic phase: after 6 months

After a CVA, it takes an average of 5–17 weeks for neurological function recovery. According to the recent Dutch guideline on stroke, a reliable functional prognosis can be made after 48 h with regard to arm-hand motor skills. If within 48 h, there is, namely, no activity observed in the wrist and finger extensors, the final prognosis with regard to arm-hand use will be poor.

Recovery of functional skills, such as putting on a blouse/shirt, is however not exclusively determined by the motor (in)abilities. Cognitive factors and ability to learning also play a role in the relearning of motor skills. The patient learns to deal with his limitations and can therefore make progress in his general functioning, despite the limitations remaining the same.

The functional recovery after a CVA is further dependent on the degree of plasticity. This will be individually defined but will also be stimulated by the patient actively seeking to (re)learn new skills and to take on challenges. In terms of neurorehabilitation, one must be able to motivate the patient to seek out these challenges and to guide him in doing so.

1.5 Communicative Impairments

A distinction is made between left- and right-hemisphere language impairments (see ◘ Table 1.5). Aphasia can occur on the basis of a left-hemisphere infarction. Aphasia is a non-congenital language impairment that in general affects all language modalities: this means speech, comprehension, reading, and writing. Worldwide, aphasia is subdivided into several categories, which are subdivided according to severity, thus:

1. Amnesic aphasia: there are in particular word-finding impairments.
2. Broca's aphasia: understanding is reasonable but expression is poor.
3. Wernicke's aphasia: expression is reasonable but understanding is poor.
4. General aphasia: all language modalities are impaired.

◘ **Table 1.5** Aphasia impairments

	Amnesic	**Wernicke**	**Broca**	**Global**
Lesion location	Diverse	Temporal	Frontal	Frontal, temporal, parietal
Speech	Normal	(Too) much	Little	Little to nothing
Language comprehension	Fairly good	Poor	Reasonable	Poor
Repetition	Fairly good	Poor	Poor	Poor
Dysarthria	No	No	Yes	Yes
Awareness of illness	Good	Poor	Good	Moderate

Source: NHS (2001)

Example from Practice 1.12

Mr. P. has Broca's aphasia. As it was taking quite a long time to make himself clear, especially at the beginning, he was given a communication book. He actually hates it – pointing to a pictogram while he knows exactly what he wants to say… Speaking just takes a bit longer.

In the trusted environment of the rehabilitation center, he no longer needs the communication book.

The people know him and he can precisely indicate what he means, without having to consult his communication book. He receives compliments and is praised by the various disciplines for his perseverance and «progress.» Mr. P. is also satisfied with himself. However, this can have its downsides.

When going on his own to the baker's, his self-confidence was dented. The shop was full of people and suddenly he had to say what he wanted. He was unable to do that; the baker became impatient just like the other people in the shop. He accepted what the baker pointed to and paid. When he got home, he felt disappointed. It had not turn out as expected. His wife also told him, «We never eat white bread.» She did not know what had taken place.

Language problems can also occur with a right-hemisphere lesion. The incidence of this is not known because these symptoms are often overlooked. The following symptoms can appear with a right-hemisphere language problem:

1. Inability to distinguish between major and minor issues
2. Problems in sentence structure
3. Monotonous speech
4. Inability to empathize with the conversation partner
5. Inability to see the humor in language
6. Difficulty with figurative language, such as proverbs, metaphors, etc.
7. Inability to get to the point when speaking

Example from Practice 1.13

Judith is a 9-year-old girl with right-hemisphere damage. She is somewhat apraxic, and for this reason, she uses the «bear method» when doing tasks that require structure in thinking.

There are four bears and each bear has a certain meaning. Bear 1 stands for «What are you going to do?,» bear 2 means «How are you going to do that?,» bear 3 stands for «What do you need for that?,» and the last bear is for evaluating, namely, «How did it go?»

Judith often needs this «bear method,» starting in the morning when she is getting dressed.

The bears guide her when she is doing that.

Her mother says: «Nobody knows it and if you were to tell them, then nobody would believe it. After all, she is verbally so good. She can talk the hind legs off a donkey. People always think that she can do more than she shows them.»

1.6 Cognitive and Behavioral Changes

Cognitive and behavioral changes as a result of a CVA occur very frequently. With respect to cognitive problems, a distinction is made between left- and right-hemisphere damage. This is an artificial classification, because the problems seldom appear in isolation. It is more efficient to describe what you see and under which circumstances and, if possible, what you do not see under which circumstances.

In spite of that, the cognitive impairments that may occur as a result of CVA can be described separately, in order to provide greater insight into the complexity of this symptomatology. This is necessary in order to be able to recognize cognitive function impairments when observing the patient.

The neuropsychologist maps out the neuropsychological function impairments. This serves various goals:

- Provides information about impairments in cognition, emotion, and behavior to the patient and those directly involved
- Is an addition to or provides an indication for further testing
- Describes the perception of the impairments
- Evaluates the treatment, the natural recovery, or the progressively increasing retardation
- Contributes to the prognosis

The resources that are used by the neuropsychologist are a (hetero)anamnesis, neuropsychological testing and observations during the consultation, or observations by the different physiotherapy disciplines.

The following cognitive functions are assessed in the neuropsychological examination: attention, memory, cognitive speed, spatial orientation, language comprehension and expression, perception, and actions. Here are some examples from practice by way of illustration.

Selective, Divided, and Sustained Attention

Example from Practice 1.14

Mr. G. has suffered a severe infarction in the right hemisphere. Beside the severe hemiplegia, the learning of motor skills was additionally limited by the cognitive function impairments that appeared after the infarction. Beside a limited awareness of illness, he also has a limitation to his selective and sustained attention. There are also memory problems. This has a restrictive influence on the learning of skills.

When going up- and downstairs, he is easily distracted by stimuli around him, and when it is quiet at last, he is fatigued. He has been taught to verbally state what he is doing, so that his attention is better focused on going up- or downstairs.

As a result of the memory problems, it is difficult for him to reproduce what was practiced 2 days earlier. After much patience and consistently offering him the same strategy, the goal was achieved: he can walk up- and downstairs safely.

Short- and long-term memory; *cognitive speed: slowed information processing (mental inertia)*

Example from Practice 1.15

Mrs. P. had a serious car accident in the summer of 2005, in which she suffered whiplash. A year later she has recovered to a level where she has the feeling that she can participate fully again within the family. That is also true, provided the conditions are good, that is to say, structured and predictable. The daily schedule is carefully set out. In one-to-one conversations, she can focus well, and there is nothing noteworthy about this lady and apparently not at parties either. Things are going well for a considerable time and she decided to have a big party to celebrate her birthday. Before the whiplash injury, Mrs. P. had a large social network and fortunately this group has remained faithful to her. All the invited guests came and it was a great party.

The next day her husband notices that she is very tired but particularly that she cannot remember much of the conversations she had the previous evening. Because she was the center of the attention, everyone wanted to speak to her and that was too much of a good thing. She takes a couple of days to recover from it, but it was nevertheless absolutely worth it.

Spatial orientation, in time, place, and person; language comprehension and expression, aphasia; perception (gnosis), tactile, visual, auditive, internal representations, and motor

Example from Practice 1.16

Mrs. L. has suffered a hemorrhagic CVA in the right hemisphere. In terms of motor skills she has recovered very well. In terms of neuropsychological problems, she is able to disguise a lot, because she is verbally strong and is able to make good use of that in a realistic manner. It is striking, however, that she has become quite a lot more anxious. At the beginning it was not noticeable, but over time it has become increasingly obvious. The reason for the anxiety lies in the fact that there are visual perception problems. She does not notice people entering her visual field from the left and this leads each time to her getting a fright. It is making her nervous and tired.

For this reason we have instructed the people in her immediate surroundings about this and everyone around her now takes account of this impaired perception. Of course, it still gives her problems in different surroundings, but in the meantime she has learned to firstly scan the entire surroundings. Also she tries to sit, if possible, with her left-hand side to the wall. That makes a considerable difference.

■ Actions (Praxis) and Apraxia

Several forms of apraxia can be distinguished.

Box 1.2 Apraxia

Several forms of apraxia can be distinguished:

1. Ideational apraxia. The person concerned no longer has any idea about how the activity must be carried out. Objects are not used properly. For example, someone will brush his or her hair with a toothbrush.
2. Ideomotor apraxia. The person concerned has problems with the order of the actions necessary to successfully carry out a particular task. He therefore knows that he can use a coffeemaker to make coffee, but the order in which water, filters, and ground coffee are used is a major problem.
3. Constructional apraxia. The spatial aspect of an action is impaired, as a result of which a person is unable, for example, to draw something properly or to put something together, such as a puzzle (this is also called the performance capacity).

Besides this classification, there are a number of other forms of apraxia that can be distinguished:

- Apraxia of the mouth area, as a result of which a person has difficulty forming things like (speech) sounds.
- When a person keeps going for too long with an action or keeps repeating it, this is called perseveration.

Apraxia generally curbs the (re)learning of skills. You do not treat the apraxia but the skill. There are various ways of doing this (see ► Sect. 7.5).

Executive functions, taking the initiative, planning, organizing, structuring, and anticipating

Example from Practice 1.17

Following rehabilitation after an infarction in the prefrontal cerebral cortex, Mr. L. has made a good recovery. He has changed a little as a person but has no reason to complain. After a couple of months at home, the people around him are being annoyed that he does so little. He used to be the driving force, and even if he had not finished off one project, he would already be starting on another one. So that no longer happens. The people around him are wondering whether he is sad, demotivated, or perhaps depressed.

The decision is made to contact the neuropsychologist, and she is able to tell them that a reduction in initiative taking is more often seen in people with a CVA in the prefrontal cerebral cortex. She gave them numerous useful tips (planning activities, using a diary, joining a hobby club), and now things are going better. Simply the fact that it is known to be a consequence of brain damage is sufficient to ease the disquiet.

Behavioral changes and cognitive dysfunction are often situation-bound. It is important to discover in which situations this occurs and also in which situations it does not. Insights into this can positively contribute to how the person functions in the ADL.

◘ Table 1.6 contains a schematic reproduction of a study (Hochstenbach and Mulder 1997) from which it is apparent that neuron psychological function impairments occur very frequently. In that same study, changes in behavior and emotional changes were measured at 9 months post-CVA. That showed that behavioral and emotional changes occur frequently after a CVA.

The study also revealed that fatigue is a massively taxing factor in respect to the entire functioning and well-being of those affected by a CVA. They experience it as a very difficult physical complaint. In 74% of the patients, fatigue is still a limiting factor at 9 months after the infarction.

◘ **Table 1.6** Outcomes of a study into neuropsychological function impairments after a CVA

Neuropsychological function impairments	Present (%)	Behavioral- and emotional problems	Present (%)
Memory impairments	61	Emotional lability	43
Mental inertia	56	Passivity	50
Difficulty with writing	56	Irritable, rapid irritation	57
Difficulty with reading	48	Depression	45
Concentration problems	55	Changed personality	57
Divided attention	53		

Source: Hochstenbach and Mulder (1997)

Fatigue has a negative influence on numerous areas, for example, on irritability, emotional lability, attention, and depressiveness. Fatigue is also named as a limiting factor with respect to general functioning in the other CNA described in this book. ► Chapter 8 is entirely dedicated to the fatigue experienced and the influence of therapy on it.

1.7 Imbalance in Burden Versus Resilience as a Result of Socio-emotional Problems

As a result of the impact that a CVA has on the person afflicted and their immediate surroundings, an imbalance can arise in the burden and resilience of the system. The resilience of the person concerned reduces in the first period, and the burden on his surroundings increases. Questions about the prognosis, the plans for the future, the amount of care needed by the person affected, etc., play a role during the rehabilitation process. After about 3 months – this is, of course, different for each patient – there is frequently a period in which the recovery of motor skills stagnates. The patient begins to realize that he will have to live with the sequelae. This can lead to feeling demotivated and/or depressed. This will reduce his capacity, and this is frequently considered by the immediate surroundings as an increase in their burden.

It is good for physiotherapists to know about this. During this period intensive therapy is necessary – the rehabilitating patient must be prepared, after all, for functioning at home – although that can be at odds with the workload and capacity model. Empathy for the feelings of the rehabilitating patient generally contributes to a greater willingness to persevere and keep making an effort during the therapy.

In ► Chap. 8 burden and resilience are discussed in more detail.

Symptomatology in Practice in the Case of Parkinson's Disease

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Summary

Parkinson's disease is a progressive disorder in which it is assumed that an active lifestyle and structural physical exercise contribute to reducing that progression (KNGF 2004). We know that through the close interaction of the extrapyramidal system with the frontal lobe, executive functioning of the Parkinson's patient is impaired. As a consequence of this cognitive limitation, the Parkinson's patient will take fewer initiatives to undertake activities. Insight into this is very important both for the physiotherapy treatment and for the patient and his family and friends. When the reason for why the Parkinson's patient takes little initiative to undertake activity is known, that cannot be attributed to unwillingness, demotivation, or depression.

It also indicates that external motivators may be needed to get the Parkinson's patient into motion. This can be his family and friends but also, for example, a diary in which the weekly events are noted.

2.1 Introduction

Parkinson's disease is a progressive disorder in which it is assumed that an active lifestyle and structural physical exercise contribute to reducing that progression (KNGF 2004). We know that through the close interaction of the extrapyramidal system with the frontal lobe, executive functioning of the Parkinson's patient is impaired. As a consequence of this cognitive limitation, the Parkinson's patient will take fewer initiatives to undertake activities. Insight into this is very important both for the physiotherapy care and for the patient and his family and friends. If the reason for why the Parkinson's patient takes little initiative to undertake activity is known, that cannot be attributed to unwillingness, demotivation, or depression. It also indicates that external motivators may be needed to stir the Parkinson's patient into action. This can be his family and friends but also, for example, a diary in which the weekly events are noted.

Interlude

At the first meeting, we see a person bent forward who is stretching their neck upward in order to see something. He walks with shuffling steps, with the arms hanging close to the body. When he turns a corner, it looks like a skater turning around a bend. During the conversation you see little facial expression, which is not caused by a lack of interest in what you have to say. When he speaks to you, the voice is quiet and monotonous.

Especially the first time, it is quite possible that substantial tremor is present, which will possibly be less prominent a second time. People make, in general, movements that are so preprogrammed that they take place automatically. In the Parkinson's patient, this is unfortunately not automatic. Functioning no longer runs on the automatic pilot, and when he wants to conclude the conversation and stands up from the chair, it will not be the first time that he falls back into the same chair. Source: Account from the author's own practice

If you have come across Parkinson's patients, this description will probably be familiar to you (see also ◘ Fig. 2.1).

Fig. 2.1 Parkinson's disease: bowed posture, arms in front of the body, small steps

2.2 Causes, Course, and Physiology

In the literature a number of causes can be found for the occurrence of Parkinson's disease. These are based only on assumptions. The following hypothetical causes are named:

1. Degeneration of brain cells and, as a result, a reduced production of the neurotransmitter dopamine. The symptoms of Parkinson's will only appear once production has reduced by 80%.
2. Reduced predisposition of dopamine at birth.
3. Accelerated aging process.
4. Dopamine is lost because radical oxygen attaches to the membrane.

In contrast to CVA, Parkinson's disease (as well as the pathologies that are described in the following two chapters) is a progressive CNS disorder. The speed at which it develops differs per individual and is partly dependent on the activity level of the Parkinson's patient himself (KNGF 2004).

Parkinson's disease is divided according to the Hoehn and Yahr scale into different stages. Within these stages, a five-point scale is used:

Early stage	
1	Initial stage with slight symptoms on one side of the body
1.5	Unilateral with emerging axial problems
2	Bilateral, no balance problems
	Possibly a slight kyphotic posture, slowness, and speech problems
	Postural reflexes intact
2.5	Moderate disease symptoms with recovery on retropulsion test

Middle stage	
3	Moderate to severe disease symptoms
	Some postural and balance problems
	Walking is affected but possible without help
	Physically independent
4	Severe disease symptoms
	Partially in need of help
	Walking and standing are affected but still possible without support
Late stage	
5	End stage
	Complete infirmity
	Walking and standing impossible without help
	Constant nursing care necessary

Parkinson's disease is caused by a disruption in the substantia nigra. The substantia nigra is located in the basal ganglia and forms part of the extrapyramidal system. Dopamine is produced here and then transported to the corpus striatum (■ Fig. 2.2).

The dopamine produced is stored in the end of the axons. An axon is a part of a nerve cell, which outside the actual cell body consists of two components:

- The axon: a cable-shaped projection that transmits the electrical signal from the cell body to the end. The axon is insulated with a substance called myelin. Thus a stimulus transmitted from your finger to the premotor cortex is better preserved.
- The dendrites: projections at the end of the cell body. These projections are in contact with the ends of the axons of other cells. If you compare it to electricity, the dendrite is the socket for the opposite axon end, hence the plug in this metaphor.

In the end of the axon, there are vesicles with a special substance: the neurotransmitter. In this case they contain the neurotransmitter dopamine. When the dendrite makes contact with the opposite axon end, this forms the signal for the release of the neurotransmitter. This process repeats innumerable times and this way the signal spreads further.

If less dopamine is produced in the substantia nigra, then the signal transmission described above between the ends of the axons will stagnate. The flow of information between the globus pallidus and the thalamus therefore is poorer (■ Fig. 2.3). Because of this, the extrapyramidal system will be, via the globus pallidus, be more dominantly present. This result in inhibition predominates excitation and leads to the stereotypical symptoms that we can observe in Parkinson's disease.

This only becomes apparent when there is more than 80% reduction in the production of dopamine. The first area to be less well supplied with dopamine will be the putamen, followed by the nucleus caudatus. This could be an explanation for why motor problems occur initially and cognitive problems only appear at a later stage. In practice, this makes

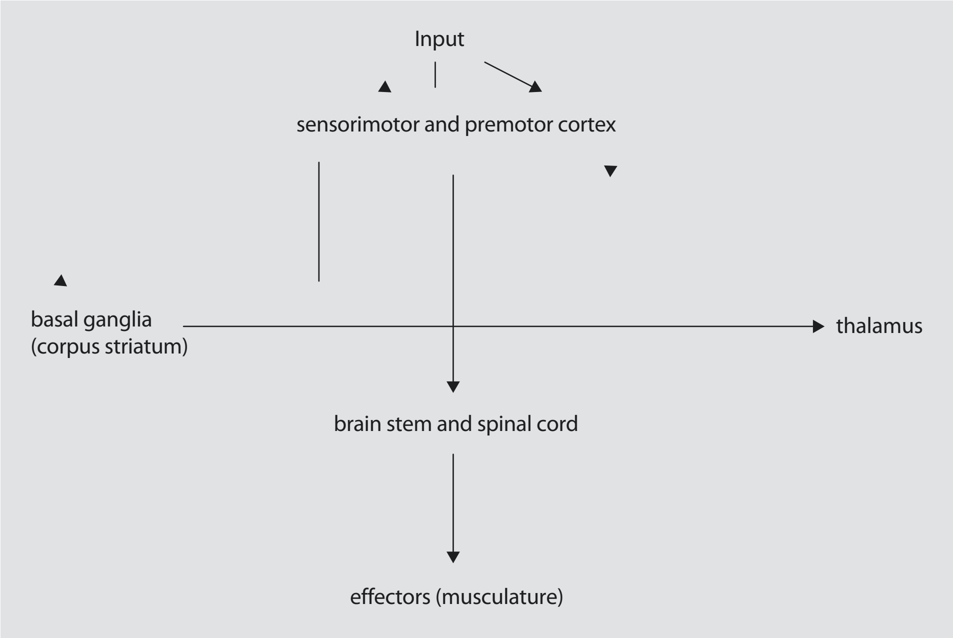


Fig. 2.2 Normal input processing

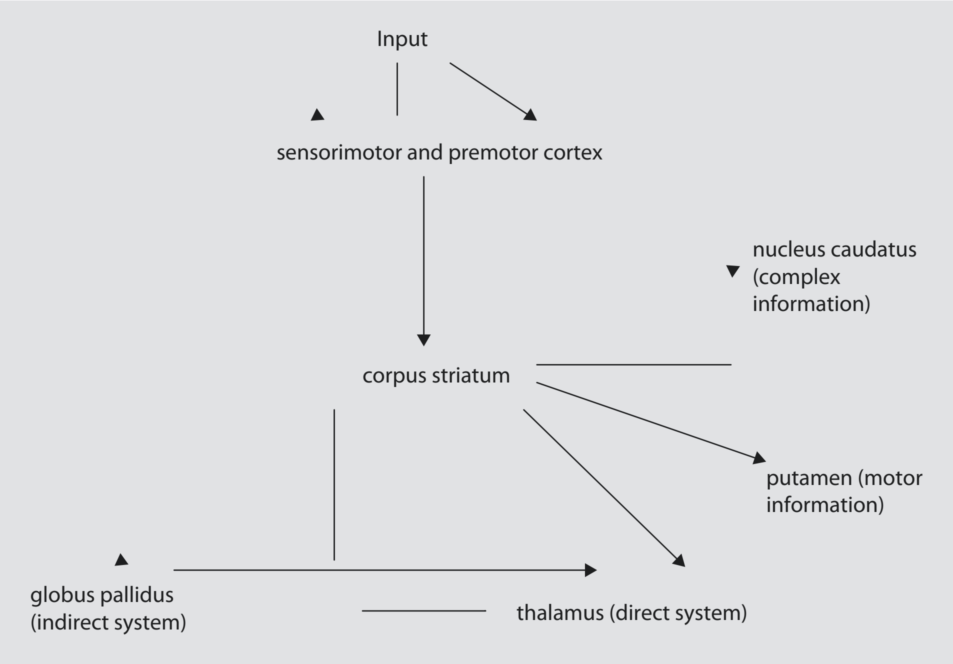


Fig. 2.3 Impaired input processing as a result of Parkinson's disease

the case for early learning of strategies. As soon as the nucleus caudatus is supplied with less dopamine, the learning of motor skills becomes less easy, because cognitive problems can arise resulting in a reduction in the ability to learning.

2.3 Symptomatology in the Case of Parkinson's Disease

The diagnosis of Parkinson's disease is made on the basis of clinical findings. Bradykinesia should be found in combination with the following primary symptoms: tremor, rigidity, or the presence of balance problems that are not caused by specific dysfunctions.

2.3.1 Tremor

We can distinguish two different types of tremors in Parkinson's disease:

- Intention tremor, which continues at approximately 6–12 cycles per second
- Resting or alternating tremor, which continues at 3–5 cycles per second

The tremors can extend over the entire body but are generally manifested firstly in the upper extremities. The tremor disappears when the patient is sleeping and can worsen in stressful situations.

Example from Practice 2.1

I was attending, as one of the guest speakers, a symposium organized by Papaver (the Dutch Parkinson Patients Association). One of the speakers was a Parkinson's patient with a stimulator in the subthalamic nucleus. During this operation a stimulator is implanted at the level of the clavicle. From there, connections are made with the subthalamic nucleus. He could operate the stimulator with a magnet. The aim of the stimulator is to reduce the influence of rigidity and inertia and to reduce tremors. The last was clearly visible. The moments that he was having difficulty finding his words were striking. The tremors then became visible again, in spite of the use of the stimulator. This was for me an extra confirmation that stress has a negative influence on central muscle-tone dysregulation (CMD) and therefore also on tremors.

2.3.2 Rigidity

Rigidity is also a form of CMD that manifests in both the agonist and the antagonist. There is a higher muscle tone in the flexors than in the extensors. The rigidity can be observed in passive movements – we then call this the cogwheel phenomenon.

The influence of rigidity on active movement has not been established in scientific studies, but there are hypotheses about it, for example, being slower in terms of motor skills. In particular when the Parkinson's patient has to work at a pace, the inertia in actions is provoked. Just like the tremors, the rigidity can increase under the influence of stressors, simply because both rigidity and tremors are an expression of CMD. CMD can increase through stressors, like having to carry out actions too fast, nervousness, pain, and suchlike.

2.3.3 Bradykinesia

Bradykinesia is a delay in starting and executing an activity, which is independent of the rigidity. It is a reduction in the automatic and spontaneous motor skills. It is known that bradykinesia, with regard to the ability to influence the primary symptoms, is by far the most important starting point for physiotherapy intervention. Expressions of CMD such as tremor and the rigidity can barely be structurally influenced, as it happens, using physiotherapy interventions. Giving the patient insights into the stressors that can affect the tremor and rigidity can, however, be worthwhile but does not have a structural effect on the CMD. The bradykinesia can, *however*, be favorably influenced using physiotherapy care.

Significance for the Physiotherapeutic Approach

When we translate this to the physiotherapy care of the Parkinson's patient, this has a number of consequences. The skill must be learned independently of:

1. Speed
2. Complexity
3. Precise muscle-tone regulation
4. Automatic execution

The last point is very relevant because it is precisely with the Parkinson's patient that we have to repeatedly practice a skill at the conscious level – automatism of actions is after all impaired. Alternative movement strategies are characterized by teaching the skill step by step, learning it as subskills and at a gentle pace. Strategies have to be deployed that promotes conscious learning of the skill, for example, by having the patient verbalize the skill during the activity. From a survey conducted among this patient population, it appears that there is a need to improve the basic motor skills (including standing up from a chair and getting out of bed), in order to thus improve the quality of life. The skills named above lend themselves really well to this approach.

Box 2.1 Alternative Movement Strategies

Scientific study has shown (Kamsma 2004) that using alternative movement strategies (AMS) can produce significant improvements in the physical accomplishments. The study was conducted as follows.

In a standardized setting using EMG, the following movements were tested:

1. Bringing the thumb and index finger together as quickly as possible.
2. *Conclusion*: the Parkinson's patient does this more slowly, and the movement will extinguish at a given moment, but no significant difference with the control group was observed.
3. Bringing the thumb and index finger together and then bending the elbow.
4. *Conclusion*: a significant delay was observed compared with the control group.

It was concluded that in Parkinson's patients a slowed down movement becomes observable:

- Under the influence of the speed of movement
- Under the influence of the complexity of the skill
- If the skill requires a sequence of movements and a precise tonic regulation.

2.3.4 Posture Regulation and Balance

In Parkinson's patients we see postural and balance problems that are not caused by propriocepsis and vision or in the vestibular system. It is very plausible that these are a direct consequence of muscle activity impairments that are reported in ► Sect. 3.1.

If exogenous balance impairment occurs, too much time is required to regulate the muscle tone so that balance can be maintained. The anticipatory ability decreases, and through that problems occur in the maintenance of posture and balance.

Example from Practice 2.2

Mrs. J. has had Parkinson's for years and the symptoms are progressively getting worse. After her husband died, it seems as if it is getting worse even more rapidly. Previously she could do two things at the same time, but nowadays she has to do her best to maintain her balance when she's standing chatting with someone, never mind being able to concentrate on the conversation. Recently someone asked her whether she was perhaps getting forgetful. They certainly meant whether she was beginning to suffer from dementia. Yet being less able to concentrate on the conversation is not so strange when you have to work really hard on keeping standing. You might miss something, but that does not mean that you're suffering from dementia!

2.4 Sensorimotor Impairments

In this section firstly those impairments are discussed which are a direct consequence of Parkinson's – the primary impairments. Thereafter the secondary motor and sensory impairments are discussed.

2.4.1 Primary Motor Impairments

A number of specific basis impairments are a direct consequence of the disease, and for this reason these are classified as the primary motor impairments.

■ Muscle Activity Impairments

There are typical abnormalities in the muscle activity patterns. It has been demonstrated that the Parkinson's patient needs more time in order to regulate the muscle tone such that a certain activity can be carried out. The muscle tone also remains stuck at a lower level than is desired during the activity (Kamsma 2004).

That not only applies to the activation but also to the relaxation of movements. The consequence of this is that certain movements can be extinguished and this could be an explanation for the characteristic «micrography» that we observe in Parkinson's patients. It is not advisable on the basis of this explanation by definition to practice alternating movement and speed of actions. The Parkinson's patient needs more time to adequately regulate muscle tone.

■ Complex Movements and Motor Planning

Incorporating a number of sub-actions into a coherent activity gives rise to problems for the Parkinson's patient (Benecke et al. 1986). Certain synergies, such as the arm swing during moving, disappear. The sequence of the one action that progresses into the other also becomes impaired. We can conclude from this that dual tasking causes problems for the Parkinson's patient.

Example from Practice 2.3

Mrs. O. experiences difficulties with the basic skills, such as getting out of bed and standing and sitting down on a chair. Once she is moving, things go well. In games she reacts adequately, certainly with ball games. The ball is thrown and she almost always catches it, even if the ball is not thrown precisely into her hands.

Her husband always watches and finds it incomprehensible. With this ball game, she does so well, but when she has to sit down on a chair, she almost falls over.

Mrs. O. has difficulty sitting down in a chair. She walks in the direction of the chair and is still so busy with «walking to the chair» that she does not know exactly what she needs to do when she gets to the chair. She quickly catches hold of the arms, when she is facing the chair, and then turns herself into the chair. Fortunately it is still going fine.

This skill is learned at the conscious level in occupational therapy. When she walks to the chair, she has to verbalize what to do. When she is standing in front of the chair, she says «stop» and then «turn.» She has to stand in such a way that she can feel the chair in the back of her knees and only then can sit down. After much repetition and consistent application, sitting down on a chair is going according to plan. It has to stay something that is done at the conscious level because it is impossible for it to become an automatism.

■ Freezing

Freezing means that someone cannot get himself moving. It can also be called the off phenomenon. Cues, such as a line on the ground, giving a command or rhythmically accompanying oneself, can contribute effectively to getting the movement started (Nieuwboer et al. 2004).

Example from Practice 2.4

Mr. W. is troubled a lot by «off» moments. He has discussed this with the neurologist, and the decision has been made that Mr. W. will inject apomorphine in his abdominal cavity. Apomorphine is a medication that ensures that the dopaminergic medicines used are better absorbed. It ensures that the receptors that absorb dopamine become more sensitive.

Mr. W. uses the medication in a time-contingent manner; this means always at fixed times. What this medication does is incredible. Because the medication immediately enters the blood circulation, you can see within just a few minutes that Mr. W. changes from a man who is very rigid and has difficulty speaking and little facial expression into a normally functioning man.

He enjoyed this effect for a long time, but eventually, when I saw again after about a year and a half, he had become very hyperkinetic as a result of the side effects of the medication.

2.4.2 Secondary Motor Impairments

The secondary motor impairments are a consequence of the direct, primary motor impairments.

■ Movement Limitations

The stereotypical posture that develops in a Parkinson's patient runs as follows.

Upper Extremity

- Shoulder: protraction
- Elbow: flexion
- Hand: frequently the thumb and index finger toward each other

Lower Extremity

- Hip: flexion
- Knee: flexion
- Ankle: plantar flexion

Trunk

Kyphosis occurs in the trunk and there is little rotational capacity in the spine. As a result, there is little arm swinging possible while walking.

The development of this stereotypical attitude is a starting point for physiotherapy intervention. The aim is to slow down the manifestation of this specific posture by means of exercise at an early stage. If it is possible to slow this development, that also has a positive influence on the reduced vital capacity and reduced endurance.

Reduced Vital Capacity

As a result of the stereotypical posture that can occur in Parkinson's patients, the lungs become a vulnerable organ. The kyphotic posture results in the lungs having less space for inspiration. This can mean that the lungs are less well ventilated and pneumonia can occur.

With further progression of Parkinson's disease, further worsening of the kyphotic posture and the anterior position of the head can cause problems with swallowing. This can result in the occurrence of aspiration pneumonia.

Reduced Stamina

Because of the developing stereotypical posture, the cardiorespiratory system cannot function optimally and, in part due to this, can contribute to reduced stamina. It is also the case that the Parkinson's patient has a reduced ability to take the initiative to undertake activities and of course this also affects the stamina. This reduced ability to take the initiative is a consequence of Parkinson's and is further explained in ► Sect. 5.

Reduced Strength

Due to impairment in the ability to take the initiative, the activity level of the Parkinson's patient is low. This will result in a loss in general strength. There is a poverty of movement, and the consequence of this is a further decrease in the activity level. The patient ends up in a downward spiral. Of course, this does not apply to all Parkinson's patients.

This downward spiral has to be broken with the help of physiotherapy care. There has to be an attempt at changing the unwillingness to move into willingness to move. This helps the general well-being of the Parkinson's patient and leads to a reduction in the progression of the disease (KNGF 2004).

2.4.3 Sensory Impairments

Sensitivity impairments can occur as the consequence of a lesion where the gyrus postcentralis (primary somatosensory cortex) or the ganglia that are projected onto it have been damaged. Because of this there is a loss, a reduction, or an enhancement in the perception of stimuli. With Parkinson's disease this does not arise because the impairment arises from the basal ganglia. With this disease we therefore rarely see problems in the practice with the sensory system as described in Sect. 1.3.3.

2.5 Communicative Impairments

Communicative impairments occur frequently in Parkinson's patients and are diverse in nature. There can be problems in both the verbal and nonverbal communications. Of course, it can be experienced as a problem by the patient, but this is also true of the person to whom the patient is speaking (recipient). This depends on how the Parkinson's patient deals with it and also the insight that the recipient has into the impairment.

The following verbal and nonverbal communicative impairments can occur with Parkinson's disease:

- Monotonous speech, this means telling a story without being able to use any form of intonation.
- Because of the monotonous speech, it is more difficult to understand what the Parkinson's patient is saying, and you regularly have to ask for clarification.
- Slow speech as a result of the slowed information processing.
- Slow responses to what is said, also a consequence of the slowed information processing.
- Loss of facial expression, as a result of which the story can become dull to listen to. It can also, when the Parkinson's patient is the listener, result in the impression being given that he is not interested.
- Excessive salivation, which can result in social acceptance problems.

Communication plays an important role in the interaction between people. As has been indicated, many problems in this domain occur. Because of this, the Parkinson's patient can become socially isolated. Providing information and explanations about this are relevant items within physiotherapy care.

2.6 Cognitive and Behavioral Changes

At a later stage, the Parkinson's patient is confronted with problems relating to complex tasks. This is a consequence of cognitive function impairments. In terms of neuropsychology, problems also arise for the Parkinson's patient. We have to be aware of this; in other words, within the domain of physiotherapy care, we must take the cognitive functioning of the Parkinson's patient into account. This means that we have to consciously deploy learning strategies in this patient population in order to obtain the best possible learning efficiency from physiotherapy care.

Problems can arise in respect of various cognitive aspects as a consequence of Parkinson's, which are discussed in the subsections below.

Information Processing

Almost every Parkinson's patient has difficulty following the pace at which information is provided. This must be taken into account. The pace has to be adapted in all kinds of areas, including when learning a skill, when switching from one activity to another, and when offering information and explanations.

- **Memory**

The Parkinson's patient has difficulty with learning new information, but not with retrieving old information (long-term memory). This means that one must be patient when teaching skills. As stated previously, the learning strategy must be adapted to this.

- **Attention**

Focused attention is good, but divided attention gives rise to problems. This is in part due to slowed information processing. Reduced mental flexibility also plays a role in this. This is also known as proactive interference. This means that if a person is busy with something and has to switch to a different subskill within that activity, this will not happen fluently. The Parkinson's patient is so focused on what he is doing that he is not able to fluently switch to the other subskill within the same activity. Dual tasks or skills where planning skills are required take place suboptimally as a result of this proactive interference.

- **Executive Actions**

Executive actions consist of taking initiatives, planning, organizing, structuring, and anticipating changing situations. Due to the close interaction of the basal ganglia with the prefrontal cortex (Kamsma 2004), it is very plausible that the problems in the executive functions are caused by impairment in the prefrontal cortex, which is controlled from the frontal lobe.

- **Mood Regulation**

Depressive feelings can be a response to the pathology but are possibly also caused by organic changes in the brain. If possible, a distinction must be made, because when organic changes occur in the brain, a positive result can be obtained with medicinal intervention. From studies it has been shown that between 25% and 50% of Parkinson's patients suffer from depressive symptoms (Taylor et al. 1986). This naturally has an impact on the motivation that is required to learn movement strategies.

Box 2.2 Using the Road

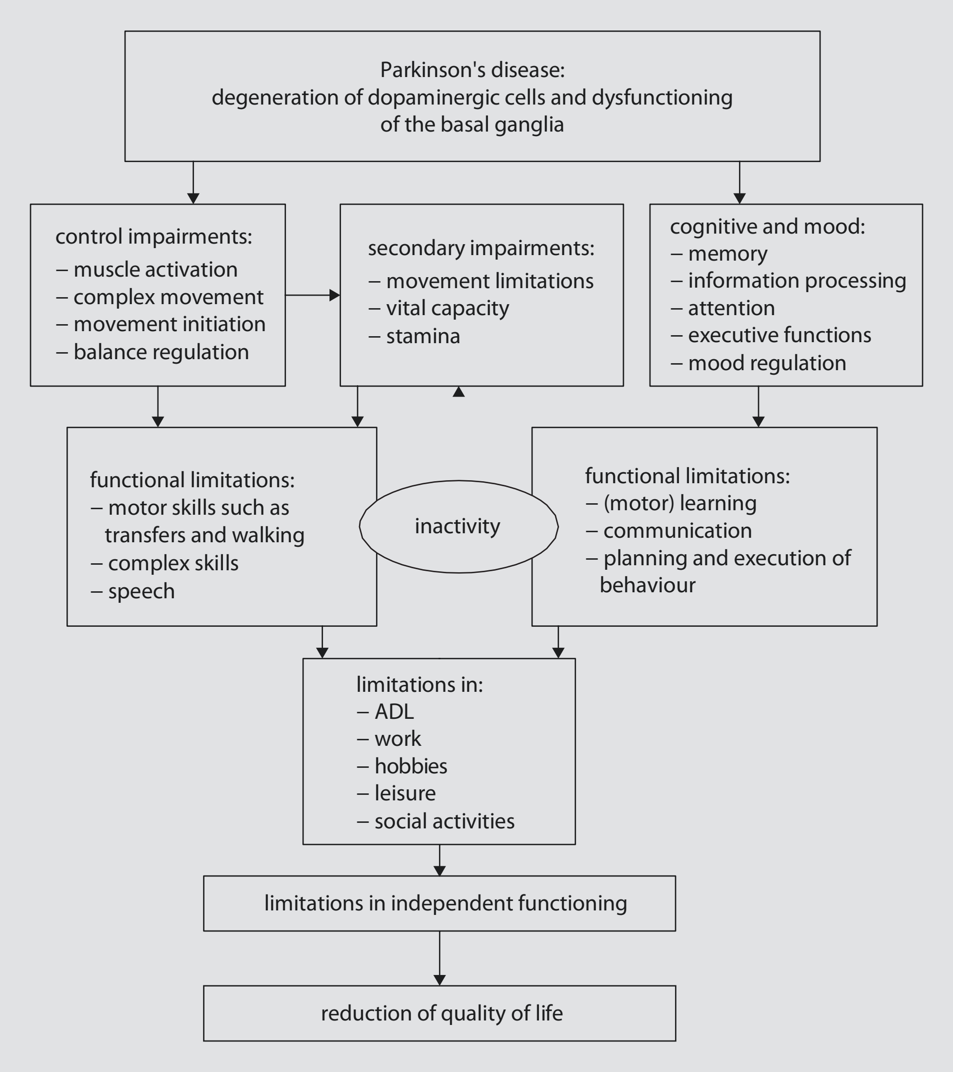
In practice it is striking that there are only a few Parkinson's patients who drive cars or cycle. Using the road seems to be a barrier that is a step too far. Being a road user requires ongoing anticipation of changing situations, and as has been described, the Parkinson's patient has difficulty with that, due to the close interaction of the extrapyramidal system with the frontal lobe. This is in contrast to CVA or MS patients who, in spite of considerable physical problems, are able to be road users (of course with the necessary adaptations to their car or bicycle). This increases the radius of action and this has a positive influence on social participation.

As a result of this fact – and because of the communicative skills – the Parkinson's patient tends to become socially isolated. If the Parkinson's patient with a mobility scooter were to use the road, because this is at a lower speed than a car, this would form a good option for traveling larger distances. It would enhance their independence.

2.7 Imbalance in Burden Versus Capacity as a Result of Socio-emotional Problems

Parkinson's disease is, in contrast to a CVA, a progressive disorder, and for this reason other factors play a role here with respect to socio-emotional problems. How socio-emotional problems are dealt with depends on the coping skills of the patient and his family and friends. How do people deal with situations that demand change?

With a progressive disorder, there is time to adjust to certain future events that may possibly come. On the one hand, that is fine because you have enough time and the opportunity to discuss matters that can be relevant in the future. On the other hand, through that process you are repeatedly confronted with a loss of independence, as a result of which the motivation to pick things up again can be endangered. Insight into factors that can influence motivation (► Chap. 10) contributes to influencing the motivational problems that can arise during the course of physiotherapy care (◘ Fig. 2.4).



◘ **Fig. 2.4** Disablement process model from Verbrugge and Jette (1994)

Symptomatology in Practice in the Case of Dementia

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3.1 Introduction

Dementia is a pathology with which the physiotherapist will increasingly come into contact. In the Netherlands, the predicted total of elderly patients with dementia lies at about 240,000 for 2015. In the same year, 28 patients per family doctor's practice will have been diagnosed with dementia. Of these, 18 patients will still be living at home. According to the forecasts, the number of dementia patients will have almost doubled by 2050.

Previously dementia patients were generally admitted to a nursing home, but the current generation of elderly people prefers to continue to live in their own surroundings for as long as possible, and the Dutch government is aiming to allow these people to live for as long as possible in their own homes. The criteria for admission to a care or nursing home have thus also become stricter. This, in combination with the increase in the number of dementia patients, means that in the future both first-line physiotherapists and those in rehabilitation centers will be dealing with elderly dementia patients. Insight into this pathology is necessary, on the one hand, in order to conduct good interventions and, on the other hand, to be able to fulfill an identifying function when a patient is suspected of developing dementia.

Dementia is a pathology that is progressive, where in the first stage, depending on which form of dementia is involved, but with Alzheimer's in particular, the cognitive function declines. To allow dementia patients to preserve the contact with their family and friends as much as possible, specific approach strategies have been developed for the different stages of the disease. This is the reason why this chapter is structured in a different manner to the previous two. Firstly, we state when the diagnosis of dementia can be determined. This is followed by a description of the different dementias and the course thereof. In ► Sect. 3.3 ◘ Table 3.1 shows a schematic overview of how you can recognize the different forms of dementia. Also the importance of insight in these different forms is stated. At the end of this section, specific approach strategies are described that can be used in the several stages of the dementia, and the term paratonia is explained.

3.2 Diagnosis of Dementia

Dementia is a clinical syndrome in which the diagnosis can be determined when a number of symptoms occur simultaneously. The symptoms may not be a consequence of psychiatric impairments; they must occur when the person is fully conscious and should have an inhibitive influence on the social participation of the patient (APA 2004).

The symptoms that appear are:

- Memory problems
- Disturbed orientation
- Impairments in the higher cortical functions, such as speech and perception
- Actions and disturbances in executive functions (e.g., planning and organization)

Table 3.1 Schematic overview of the symptomatology of the various dementias

Symptoms	Alzheimer's dementia	Vascular dementia	Lewy body dementia
Memory	Memory impairments (mild) that increase	In the beginning not an obvious symptom in the foreground	Slowed retrieval of information
Speech	Intact, but sometimes disoriented	Slowed, word finding problems	Monotonous and hypophonia
Orientation	Becomes distorted	Not necessarily	Good
Motor skills	Seems intact, but praxis ↓	Praxis and planning of actions ↓	Motor skills resembling those of Parkinson's patient
Taking initiative	Diminished on the basis of loss of interest	Diminished on the basis of depression	Not disrupted at the initial stage
Depression	Normal, sometimes even euphoric	Present because of good awareness of disease	Unknown
Awareness of disease	Diminished presence	In the initial stage good	In the initial stage good
Muscle tone	Initially normal muscle tone	Muscle-tone dysregulation	Rigidity
Course	Gradual	Erratic course with ups and downs	Rapidly progressive

3.3 Various Forms of Dementia

There are several forms of dementia:
1. Alzheimer's dementia (70%)
2. Vascular dementia (20%)
3. Lewy body dementia (10%)

3.3.1 Alzheimer's Dementia

Alzheimer's dementia is the commonest form. The accumulation of amyloid plaques between the nerve cells in the brain is characteristic of this disease. Amyloid is a protein fragment that is created by the body and which is normally broken down in the brain. The breakdown of this protein fragment is disrupted in Alzheimer's patients, and in fact an aggregation of these fragments occurs. This aggregation of protein fragments takes place between the nerve cells. One consequence is that there is a disruption in the information processing between the nerve cells in the brain.

Tau proteins stabilize the microtubules that form part of the cytoskeleton of the neuron. When tau proteins become defective and insoluble, they can form neurofibrillary tangles. These tangles contribute to the pathology of Alzheimer's disease by interrupting the transfer of information along the nerve fibers. Tangles destroy a vital cell transport system made of proteins.

The American Alzheimer's Association offers an explanation for the consequences:

> **In healthy areas:**
> The transport system is organized in orderly parallel strands somewhat like railroad tracks. Food molecules, cell parts and other key materials travel along the "tracks." A protein called tau helps (…) keep the tracks stay straight.

> **In areas where tangles are forming:**
> Tau collapses into twisted strands called tangles. The tracks can no longer stay straight. They fall apart and disintegrate. Nutrients and other essential supplies can no longer move through the cells, which eventually die.
> Source: ► http://www.alz.org/braintour/tangles.asp

Initially with Alzheimer's disease, cognitive problems predominate, such as memory and orientation problems. However, problems with motor skills occur earlier than is generally assumed. These motor problems are expressed especially at the skill level as a result of problems with planning activities or a mild form of apraxia. The physiotherapist must be aware of this, because a combination of motor impairments and memory and orientation problems can be an indicator of emerging Alzheimer's dementia. This is, namely, not only attributable to normal biological aging processes.

Interlude

I want to ask her something, but she has already left the room. Ten minutes. The big hand is pointing to seven. When it gets to nine, that will be 10 min. But what then? What needs to happen? I close the book and push it away from me. I stare at the black hands on the gold-colored wall clock. There is no second hand on it. It seems as if the clock is standing still. It is a modern one; it doesn't tick.

I go to the kitchen, sit down at the kitchen table, and look at the bright red kitchen clock on the wall, an electric one with a gold-colored second hand that ticks its way around the dial with slight twitches. I do not let my eyes stray from it for a moment. I have always been a man of the clock. Punctual. You cannot say that about others.

One more time and the big hand will be on nine. Then the 10 min will be up. It is there. I stand up and walk into the living room.

«Vera,» I call, «time's up.» I walk through the room into the hall. «Vera, Vera, the 10 min are up, » I call as calmly as possible. Then I hear her answer coming from the bedroom. «Turn the oven off then, will you.»

I do not know how fast to get back, to carry out her instructions. When I hear the rushing sound of the gas cease, I sit down at the kitchen table with a sigh of relief. It's only thanks to her that I've been able to carry out this task. Otherwise I wouldn't have known what I had to do. That you can suddenly be so alienated from the most everyday actions worries me. I have no explanation for it.

From: *Hersenschimmen [Out of Mind]*

■ Course

Before memory impairments become clear with Alzheimer's dementia, both the patient and those immediately involved with the patient indicate that there is a decrease in interests. The suspicion is that there is an underlying depression. The patient himself is unable to properly indicate what is actually happening. As long as the patient in daily life continues to function normally or his functioning is at most somewhat odd, the diagnosis of dementia cannot be made (APA 2004).

Forgetfulness that deviates from biological aging and a slight euphoric feeling can be indications of an emerging dementia. Normally we can store about seven things in our short-term memory and then reproduce them. In dementia patients, that is limited to two or three. In such a case, there is a mild cognitive impairment (MCI) (World Health Organization). People with MCI are not demented, but do have a five to six times increased risk of developing dementia (Chertkow 2002).

When someone with MCI is removed from his or her own direct environment, for example, when there is a sudden admission to hospital, you see that the functioning deteriorates. This is also known as «cascade breakdown.» The memory problems can suddenly become much more prominent and have a restrictive influence on daily functioning. Apparently there seems to be an acute dementia. In reality the memory problems already existed, but had not yet been recognized as such. If the person concerned is removed from his trusted environment, the limitations in ADL then come to light. This proves that a safe trusted environment contributes to better functioning.

As the disease progresses, language will give rise to problems, not only in terms of comprehension, but language processing will also require extra time. The patient does not notice an incorrect answer on a question, and he tries out with all kinds of evasions and excuses to avoid answering the question. This is called «façade behavior.» This occurs frequently with Alzheimer's dementia.

With increasing disease progression, the patient loses the control over his life. The family or home care must increasingly often lend a hand, and activities such as cooking, dressing, and washing become ever more difficult. The next stage is disorientation in time, place, and person. This disorientation can lead to straying or restlessness, and in some cases this lead to dangerous situations. Continuing to live in the trusted environment will cost those directly involved a lot of energy.

In a further stage, the patient encounters difficulties caused by aphasic problems. He can no longer come up with the names of acquaintances or objects. The vocabulary declines and sentence structure is weak. Reassurance is no longer understood and the restlessness increases. When the nocturnal restlessness increases, this leads to intolerable situations, and admission to care is indicated.

A whole process precedes the decision to admit to care, but then it is still a very serious decision. Admission to a protective environment, such as small-scale living projects, or in the nursing home represents a definite farewell to daily living. It is a difficult decision that has to be taken by those most closely involved for another person.

The progression of the dementia continues, and eventually the cerebellum falls prey to the disease process and substantial motor problems arise. The patient becomes increasingly stiffer, dependent on a wheelchair or bedridden, and adopts a fetal position. Often he is unable to lift his head anymore and dependent on the care staff to feed him and give drinks. The patient becomes incontinent for both urine and feces and in the end is so weakened that he dies.

3.3.2 Vascular Dementia

A number of processes lie behind the occurrence of vascular dementia. It can arise on the basis of an arteriosclerotic process, through multiple small infarctions or because of a leak in one of the small blood vessels. As these processes progress, brains become dysfunctional and memory impairments become clearly visible. This happens in combination with other higher cortical functions that become disrupted, such as speech, perception, action, and problems in the executive functions.

Apart from disruptions in the brain cells, the connections between the brain cells are also disrupted. These connections consist of long nerve endings that are insulated with myelin. As a result of biological aging, the quality of this insulation declines (Eulderink 2004). This process is called demyelination. Biological aging is a gradual process. If the demyelination is occurring at a noticeably faster pace, that can be a sign of an emerging vascular dementia.

Vascular dementia occurs more frequently in people with high blood pressure, with increased cholesterol levels in the blood, with smoke, and with hyperhomocysteinemia. The last one is a metabolic disease in which deficiencies of vitamins B12 and B6 and folic acid lead to elevated levels of homocysteine. This is one of the reasons why a blood test must be done in patients with dementia. If it appears that there is a deficiency in vitamins B12 and B6 and folic acid, that can be remedied medicinally.

■ Course

The impairments seen in vascular dementia depend on the nature, the extensiveness, and the localization in the brain where the damage occurred. In the initial stage, memory problems are not the predominant symptom of this type of dementia.

Inertia in actions and speech are clearly present in the initial phase. Problems with finding words or difficulty switching from one topic to another are regularly reported in practice.

The patient is personally much more aware of the failures at the cognitive and motor level than people who suffer from Alzheimer's. Frequently in part because of this disease awareness, behavioral impairments with changeable moods do arise, which can lead to depression. At a later stage, memory problems arise, a symptom that has to be present if the diagnosis of dementia is to be made.

On an MRI or CT scan of the brain, lesions can be seen in the brain such as infarctions and white matter abnormalities. These abnormalities increase over the course of the disease. The course of vascular dementia is not as gradual as that of Alzheimer's dementia. It is frequently irregular, step by step, with moments of deterioration and afterward partial improvement.

On physical examination, abnormalities can be found in reflexes and muscle strength. The general condition is poorer in comparison with that of the Alzheimer's patient. In part as a result of this poor general condition, a patient with vascular dementia will in general be admitted earlier to a nursing home. The average length of such an admission is several years less for these patients than for Alzheimer's patients.

When there is further progression of the vascular dementia, the difference in symptoms when compared with those of Alzheimer's dementia decreases. It becomes more difficult to distinguish between the different dementias. Eventually the vascular dementia patient will die because of very poor general homeostasis.

3.3.3 Lewy Body Dementia

In patients with Lewy body dementia, abnormal protein aggregates are found throughout the brain. The doctor who first described this form was Friedrich Lewy. Lewy bodies are also seen in Parkinson's patients, but they are then located solely in the basal ganglia. Lewy body dementia has been recognized as a separate syndrome since 1961. This form is distinguished by the presence of the following symptoms: variable degree of confusion, hallucinations, and walking impairments which also appear with Parkinson's disease (see ► Chap. 2).

- **Course**

In Lewy body dementia, just as with Alzheimer's dementia, the first symptoms of confusion are characterized by memories and orientation impairments. The variable sustained attention, the restlessness, and the «pulling» at bedclothes or clothing are noticeable symptoms. Other symptoms include fainting, depression, sleep impairments, and auditory hallucinations. Recently research has shown that patients with Lewy body dementia respond well to medicines that are registered to slow the progress of Alzheimer's (rivastigmine, galantamine, and donepezil). Patients become more lucid, attention improves, and they are less confused. How long the effect of this medication lasts and what it implies for the progression of the disease are still not yet known.

The fact that this type of dementia has not been recognized for very long means that the course can less clearly be described. Just like the Parkinson's patient, the motor problems arise first (shuffling gait and an increased chance of falling), followed by the cognitive impairments. It seems that once the psychiatric symptoms such as the hallucinations and the changeable attention become more noticeable, the dementia often progresses quickly in severity. This means that patients can change within a period of a few months up to a year from being relatively healthy people into someone who is wheelchair bound and severely demented. When the ability to walk is lost and the patient becomes bedridden, the end is rapidly in view.

3.3.4 Mixed Dementias

There are also mixed dementias. In some patients with vascular dementia, amyloid plaques are found in the brain. This is then called «mixed dementia.» When Alzheimer's dementia has been proven, the diagnosis of a mixed dementia becomes more likely if the patient has an anamnesis of high blood pressure, cardiac arrhythmias, excessively high cholesterol level, insulin-dependent diabetes, and TIAs. With further progression, the difference in symptoms between the various dementias declines, and it is difficult to distinguish between the different syndromes.

3.4 Recognition of the Various Dementias

◘ Table 3.1 gives a schematic overview of the early symptomatology of the various forms of dementia. From this, the physiotherapist should probably be able to recognize the various forms of dementia in the initial phase. Being able to do so is important because there are differences in the prognosis and speed at which the dementia syndrome develops.

3.5 Insight into the Different Stages of Dementia

The course of dementia runs in stages, and there is a gradual decline in both cognitive and motor functions. In all these stages, the physiotherapist can be of added value in the care of this patient population. He must however be familiar with the various approach strategies. On the one hand, he must know which approach strategies there are and on the other side when he can use them. This means that he will also be regarded as being able to recognize the various stages in dementia. On the basis of the course of the syndrome as what occurs in many Alzheimer's patients, a classification has been made into seven stages. Insight into these stages gives the multidisciplinary team the ability to match the approach strategies to the stage.

◘ Table 3.2 shows the *Global Deterioration Scale* (GDS) according to and, added to that, which approach strategy is appropriate at which stage.

3.6 Approaches to Dementia Patients

In this section, the most important characteristics of the different approaches are described, which are frequently used at the different stages of dementia.

3.6.1 Stimulation of an Active Lifestyle and Training of Muscle Strength and Stamina

Studies have proven that an active lifestyle contributes to reducing the risk of dementia. Conversely, people who are inactive have a greater risk of developing dementia (Heyn et al. 2004; Larson et al. 2006; Friedland et al. 2001; Churchill et al. 2002). Physical exercise three times per week or more results in a 32% reduction of the risk of dementia.

Meta-analyses in 48 studies show the impact of exercise on cognition (Colcombe and Kramer 2003). Physical activity has a direct positive effect on cognitive functioning (Chertkow 2002). This was found in both cognitively healthy persons and persons with MCI compared with the various control groups. Physical activity seems to give only a direct improvement of cognitive functioning during and shortly after the training period.

Executive functioning is the most frequently tested. This function has to do with initiating goal-oriented behavior, anticipating new situations, setting priorities, and picking up, respectively, exploiting signals relating to one's own behavior. According to various studies, physical activity has the most positive influence on executive functioning (Churchill et al. 2002; Colcombe and Kramer 2003; Scherder and Eggermont 2006).

Table 3.2 Global Deterioration Scale according to Reisberg

Stage	Loss of skills	Approach strategy
Stage 1 No cognitive decline and normal functioning	Not applicable	Stimulation of an active lifestyle
Stage 2 Very mild cognitive decline The patient himself experiences decline, and surroundings do not	Forgetfulness with regard to names, appointments, or where belongings have been put away Subjectively experienced word finding problems No objective proof for problems in complex activities, such as work	Stimulation of an active lifestyle Training of muscle strength and stamina
Stage 3 Mild cognitive decline or the beginning of dementia «The threatened me»	Perceptible problems in activities Orientation problems in unknown surroundings Routine actions are intact (e.g., cooking)	Stimulation of an active lifestyle Training of muscle strength and stamina ROA (reality orientation approach)
Stage 4 Moderate cognitive decline and emerging Alzheimer's dementia	Observable problems in ADL, such as grocery shopping, cooking, and organizing something Self-care is intact	Training of muscle strength and stamina ROA Validation Gentle care
Stage 5 Moderate to severe cognitive declines and further progressed Alzheimer's dementia «The lost me»	Difficulty with simple elements of self-care With stimulation and incidental help, self-care is adequate	Movement activation program (MAP) Validation Gentle care
Stage 6 Severe cognitive decline and advanced Alzheimer's dementia «The sunken me»	Self-care declines in phases (see below) Problems with dressing (praxis) Help needed to get in and out of the bath Inability to visit the toilet independently Double incontinence	Validation Gentle care Passivities of daily living (PDL)
Stage 7 Very severe cognitive decline and end-stage dementia	Speech and simple motor skills decline Fetal posture generally arises in the following order Vocabulary <6 words Understandable vocabulary at the most one word Loss of walking function Is no longer able to sit up straight The ability for (spontaneous) expression disappears Is no longer to hold head up straight	Gentle care PDL Van de Rakt method

In this table the descriptions found in the first column are «the threatened me,» «the lost me,» and «the sunken me.» This concerns a different classification of the different stages of dementia in which the terminology used indicates something about the state of mind of the dementia patient

In short, stimulating the elderly to maintain or adopt an active lifestyle is an objective that should be part of their physiotherapy care.

3.6.2 Reality Orientation Approach (ROA)

The aim of the reality orientation approach is to stimulate and activate confused persons to rediscover the lost contact with reality (they are «threatened,» but not yet «lost») and thus, in this way, to slow the progress of dementia.

Dementia patients who have the most to gain from a reality orientation approach have symptoms that match stages 3 and 4, as described in ◘ Table 3.2. These stages are characterized by an emerging dementia in which confusion occurs. The person concerned has the idea that reality is regularly slipping from his grasp, and he would like some help in keeping a hold on it. When using this approach, it is necessary to find out whether it fills the need of the dementia patient. If so, then it is possible to offer this method in a supportive manner. If not, the dementia patient can experience it as being too confrontational and being brought back to reality as distressing. This can cause agitation.

A characteristic principle of reality orientation is that an appeal is made to the intact functions of the elderly patient with dementia, assuming that confusion and disorientation are influenceable factors. The means by which that is done is the repeated offering of realistic information over time, place, and person and the stimulation and encouragement of independent behavior.

Interlude

«Where can the children be? »

«The children? In Holland, of course, where else would they be?»

«No, I mean the ones from here. » I point outside. «Cheever's children, the Robbinses and Tom's little Richard. »

«But Maarten, it is Sunday today. Come, your tea's getting cold.»

That I had forgotten that. And tea? I could have sworn it was morning. But as I look through the other window in the direction of the sea, I can tell that it must be later. Behind the grey mist lurks a pale sun. It must be this mist that has deceived me. Mist stops the light. Before I sit down, I glance quickly at the wall clock. It's been 3 h.

From: *Hersenschimmen [Out of Mind]*

For orientation in time, use is made of easily read clocks and boards, on which, for example, the day, the date, and the day's program are indicated.

Signs can support orientation in space. It is important that these are regularly pointed out to the dementia patient. By regularly seeing this signposting, «repeated mental practice» occurs, which means that the information is stored unconsciously and the patients can, in the long run, find their way about independently.

Orientation in person is supported by using mirrors, nametags, and photographs (e.g., of family members).

Another component of the reality orientation approach is offering a structured day program. This is characterized by structure and predictability. With this, there is an attempt to create a feeling of security.

A reality orientation approach can be a legitimate method for the emerging dementia patient, provided that the patient has been properly observed or it fills a need. It must therefore be supportive and contribute to a better grip on the situation. If that is not the case, it would be better to opt for a different approach strategy.

NB: Previously reality orientation training (ROT) was where the focus lay on training cognitive functions (memory and orientation). In practice this approach turned out not to be effective, because the functions thus trained did not improved (Fassoti 2005). The resources that are applied with the reality orientation approach have many commonalities with components from cognitive rehabilitation (see ► Chap. 7).

3.6.3 Validation Approach

The term *validation* derives from the Latin word valor, which means value. The basic principle of validation is that every person is valuable and that each human behavior has a meaning, irrespective of the degree of disorientation resulting from, for example, dementia.

The validating approach is primarily aimed at relieving stress and restoring the sense of identity and self-esteem of disoriented dementia patients. The goal is to achieve inner peace. This can have a favorable influence on maintaining contact with one's surroundings.

By connecting with the actual world, the dementia patient has the feeling that he is being taken seriously. As a result, he can feel less threatened and less lonely. In order to connect to the reality perceived by the dementia patient, you need to have a great deal of empathy as a physiotherapist.

The validation approach, which is used a lot in psychogeriatric care, was developed in the 1960s by Naomi Feil (1989). She included a number of psychological principles in this approach. To determine whether the validation approach is effective in a specific stage, she takes a closer look at the process of confusion in dementia. Feil distinguishes four stages of confusion in dementia. These vary from mild to very severe. The following classification is used:

1. Mild confusion and poorly oriented
2. Time confused
3. Constant or repetitive movement
4. Vegetation

The following terminology is also used with respect to these stages: the threatened me → the lost me → the sunken me.

▪ The First Stage: Disorientation

With the validating approach, a distinction is made between *disorientation* and *time confusion*. In the initial stage of the dementia process, there are imprinting and memory impairments. These lead to disorientation and confabulation (telling a story based on false memories). The time however retains its structuring nature. In the disorientation stage, the dementia patient is aware of the confusion that is occurring, and he clings to the present. The notion of this confusion makes him anxious. At this stage he wants to be helped to keep a grip on contemporary reality.

His «I» is still untouched. By means of confabulation and trying to maintain some decorum, the «I» defends itself. It assesses and denies that something is happening.

Interlude

«Where were you? »

«At Dr. Eardly's.»

I'm scared. «There's nothing wrong with you, is there? »

She lays her hands on mine. «I went for you, Maarten. You've been so restless recently. You do things that you no longer remember shortly afterwards. Strange things. I went to talk about it with Dr. Eardly.»

«I feel absolutely healthy. Strange things? What kind of strange things? » «When I came home the whole kitchen was strewn with chicken bones. » «Robert,» I say hesitantly.

«Half a chicken Maarten. You ate half a cold chicken from the refrigerator. A tin of liver pate, a couple of pieces of pineapple and a box of cookies. »

«A healthy appetite for an old man, that's all I can say.»

«It's no laughing matter Maarten, Dr. Eardly says we can do something about it together. And he's given me tablets for you, for the night. »

«I sleep perfectly well.»

«Sometimes you get up in the middle of the night. You get dressed. Then you no longer know the difference between day and night. »

«That damned rotten winter too,» I mumble. I give her a penetrating look, almost stern, as if I want to persuade. But in fact I'm begging her for understanding for something I don't understand myself.

From: *Hersenschimmen [Out of Mind]*.

At a following stage of the dementia process, time loses its structuring function, and the dementia patient ends up in a timeless generality. This timeless generality is also known as *time confusion*.

The Second Stage: Time Confusion

In this second stage, the assisting and defensive «I» disappears. The dementia patient is more open for communication. In particular communication about memories has a strong, emotional component and often appears in this stage associatively. The dementia patient has no sense of time anymore, and connection to the world he experiences gives him the feeling of being taken seriously.

The Third Stage: Constant or Repetitive Movement

In this stage the dementia patient becomes more and more withdrawn, and verbal abilities gradually disappear. Words are replaced by movements and rhythmic repetitions. At this stage he isolates himself and attention for something else is difficult. Nonverbal communication starts to predominate; this means touching, speaking in a warm caring manner, and eye contact. Just like in the previous stage, it is possible to go along with his perception of reality.

It is clear from this description that dementia patients both in the second and in the third stage according to Feil benefit from the validating approach. In these stages they have withdrawn into their inner reality. By connecting with the world as they experience it, memories are given the space to be recalled. One of the means of recalling memories in dementia patients is by reminiscence. With this method smells, music, and photographs are used as aides-memoire.

Interlude

Vera puts her finger on male and female figures and mentions names. Kitty, Janet, John, Fred. Three years ago, in Rockport.

I say nothing.

«You need to concentrate better, » she says. «You still know it all, but you have to do your best. » She taps gently on my forehead with a glossy nail-polished nail. I draw the album towards me and thumb back through it. Then it's just like fog is lifting.

«This is a photo taken from the window at home. Where you see all those greenhouses and wooden sheds, that's where a different world started, a water world full of punters, flat-bottomed barges, pontoons and white footbridges over the ditches. And in the wintertime you could skate there forever. Friesland ice skates. Can you still feel them squeezing your foot with those tight multi-coloured laces and that stiff leather heel? »

I look at Vera. She nods. «I remember all that too, » she says. «I went with you often enough. « I'm so happy that she says that that I want to tell her more, without using those photos. »

From: *Hersenschimmen [Out of Mind]*.

■ The Fourth Stage: Vegetation

In this stage the dementia patient retreats inward, shutting himself off completely from the world. Family members and care staff are no longer recognized, and he no longer responses to voice or eye contact. Touch is frequently still perceived, because that feedback system remains intact the longest. An empathic and loving manner of caring is important.

Interlude

Nobody. Perhaps everyone has left. They've left me here to rot in bed. I hear water flowing. Soon the place will be flooded and I can't get out of bed. I kick around. The bed creaks but the straps don't more an inch.

Somewhere in the space a door opens. I don't dare to look because I've no idea who's coming in. And because I am ashamed of myself. Like an animal lies I'm lying here in my own muck. I keep my eyes firmly closed. I hear someone retching.

Feel how hands strip the pyjamas off my body. They want me to move forward. Must open my eyes now and see an old man in the mirror, an old man with a slack wrinkly belly streaked with shit. I smile with relief. At least that isn't me!

Two women lift me into a bathtub, an old one and a young one.

I lie in this water as if I no longer had a body. Only where they touch me, wash me, it exists very briefly again.

From: *Hersenschimmen [Out of Mind]*.

3.6.4 Gentle Care Approach

Just as with validation, the perception of the dementia patient takes center stage in gentle care. The aim of gentle care is to create an environment in which the patient feels safe, resulting in anxieties and uncertainties reducing or disappearing.

This vision is based on attachment theory. Every individual needs one or more persons to whom he can be attached in order to feel safe in his surroundings. Degradation of memory leads to dementia patients being incapable of carrying out actions. This leads to a situation of dependence, which is similar to that of a young child who still has to learn a lot of skills and actions. The phenomena that accompany dementia (such as feelings of threat, fear, and insecurity) ensure that attachment behavior is reactivated. As a result the dementia patient seeks a safe base and warmth.

In this approach the entire team of care workers is involved; this means the doctor, psychologist, physiotherapist, occupational therapist, activity leaders, care staff, and nursing staff.

If the classification of dementia according to the «I» classification is used, then gentle care can be applied at each stage of dementia. The method consists of a number of characteristic focus areas: proximity, recognizability, homeliness, liberty, and family.

■ Proximity

For the dementia patient, it is important that the caregiver does not distance himself or herself and is not afraid of physical contact, like a hug. It is also important that the caregiver goes along with the patient's world and fits into that perception.

■ Recognizability

The surroundings of the dementia patient should be familiar and calming. In order for the unit to resemble a hospital department as little as possible, furniture is chosen so that a homely atmosphere is created. It is important that the care staff wear their own clothing and not a uniform. A small care team around a fixed group of residents improves the bond between the care worker and patient.

■ Homeliness

In a psychogeriatric unit, there should be as few rules as possible. There should be a recognizable structure to the day each day. This does not mean that each day should be the same, but that there are fixed points in the structure of the day. An example of this is breakfasting together at the table in the living room in the morning, where the patient is given the chance, for example, to spread his own bread. Another example is looking after pets. These can reinforce the feeling of homeliness. With these activities it is important that the resident is given the freedom to set his own pace.

■ Liberty

For mobile residents it is important that they experience liberty by being able to walk about unrestricted. This has to be taken into account during the building's construction in order to allow this, by creating an indoor walking route. The dementia patient should experience being restricted in his liberty as little as possible, and therefore there should be as few closed doors as possible. It is of course a closed unit, but through its construction a feeling of freedom is created.

- **Family**

The family plays an important role in the patient's contact with reality. Within gentle care there is plenty room for contact between the patient and family. There are no fixed visiting times. For the family members, it is important that they have the opportunity to help with the care and that they can join in with a meal and if necessary can stay and sleep on the unit.

Small-scale living is founded on the basis of these characteristics.

3.6.5 Passivities of Daily Living (PDL) Approach

Normally one of the aims of therapy is to improve or, through adaptations, make the activities of daily living possible. With PDL the shortcomings in ADL are actually accepted and the gaps in care are taken over. The definition of PDL means the following: a complex of actions, measures, and provisions that contribute to optimal supervision, care, and nursing of people whose self-care deficits can no longer be alleviated.

From this definition it becomes clear that there is an assumption that the lost ADL functions will no longer return. Training of these functions is not a treatment goal, and the situation and the self-care deficits that have arisen are accepted. Studies have shown that care staff of the PDL method is to reduce the negative effects of the passivities that have arisen as much as possible. Negative effects are pain, discomfort during daily care (for both the care recipient and the caregiver), contractures, bedsores, etc.

Example from Practice 3.1

Mrs. P. is 85 years old, lives in the nursing home, and has Alzheimer's dementia. In recent weeks she has declined rapidly. She is no longer able to stand and walk. In the last few days, she has indicated that she has a lot of pain when being cared for, and the care staff is hindered by the presence of paratonia. Sitting straight up in the chair is getting more difficult.

In the end there is a bedridden patient with muscle tone that is raised to such an extent that even when lying on her back her head floats above the pillow. Caring for Mrs. P. is accompanied by pain and it makes her agitated.

On the PDL observation list, she scores 28 points. This is a reason to implement PDL in the care of Mrs. P. Spasm inhibition, a good bed position, and consistent rules for the transfers form part of the implementation. A microbead mattress is also requested and she uses a Kelvin seat element for sitting (PDL chair).

An evaluation is conducted after 3 weeks: Mrs. P. indicates that she is in less pain when being cared for and when her position is changed. The paratonia has reduced in extent, as a result of which caregiving is easier. It seems that the patient is finding this more pleasant. She is quieter in any case.

The effects of PDL have been evaluated in research studies. ◘ Table 3.3 indicates what the effects are of implementing PDL.

There is still little scientific evidence to support PDL. Qualitative research produced the following conclusions. PDL has a positive influence on the well-being of those requesting psychogeriatric help. The chance of the patient being overloaded is zero, because there are no expectations with regard to the ADL. This results in an increase in relaxation. Through the lack of expectations and the peaceful surroundings, the circumstances are such that the patient requesting does not have to react with anxiety. This results in the chance of agitation being reduced.

Table 3.3 The effects of implementing PDL

	The Netherlands	**Belgium**	**Total**
Effects on patients	*N* = 50	*N* = 23	*N* = 73
Less tension	98%	91%	96%
Higher satisfaction/well-being	90%	87%	89%
Function better, positive behavioral changes	60%	48%	56%
Less decubitus	38%	83%	52%
Fewer contractures	44%	65%	51%
Less medication	28%	17%	25%
More grip on daily living	8%	13%	10%
Others	16%	9%	14%

Source: Dijk (2006)

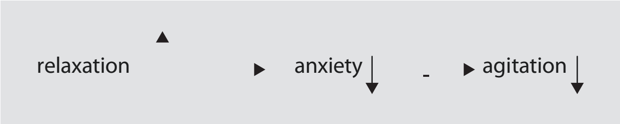


Fig. 3.1 Schematic diagram of the conclusions of qualitative study into PDL

Figure 3.1 shows the conclusions schematically.

PDL resources contribute to reducing the physical and mental burden of caregivers. The application of PDL also has a positive effect on them. Within the PDL a classification has been made consisting of seven focus areas, the care moments within 24-h care:

1. Lying
2. Sitting
3. Being washed
4. Being dressed
5. Being changed
6. Being moved
7. Being fed

When applying this approach and its related working method, insight is required into:

- Spasm-inhibiting techniques
- Undesirable occurrence of reflexes
- Ability to supervise the transfer efficiently
- Optimal postures and supportive measures
- The physiotherapist plays an instructive role when these care moments are implemented.

3.6.6 Van De Rakt Method

In the final stage of dementia, the patient is completely bedridden, with as a striking phenomenon the fetal position being adopted. This was described by Rakt (2001). There are two types. The one has a predominating flexion component in both legs and arms. The second type is characterized by a predominating flexion in the arms and extension in the legs (◘ Figs. 3.2 and 3.3).

Within the traditional forms of treatment, interventions at these stages are focused on the symptoms; this means especially suppression of contractures and prevention of decubitus. Van de Rakt however calls for treatment of the possible cause, stating that the occurrence of a fetal position is caused by a perception problem (Rakt 2001; Rakt and

◘ **Fig. 3.2** Flexion component

◘ **Fig. 3.3** Extension component

Louter 2006). This is a response to a lack of stability and tactile input among other things, as a result of which the patient seeks internal input. This is achieved by creating as much internal tension as possible. It is also possible that the high tension that a person builds up is caused by the proprioceptive system also failing in the final stage. Because of this, body awareness disappears, and by way of compensation, high muscle tension is created in order thereby to obtain information.

The treatment according to Van de Rakt should therefore be based upon bringing about a reduction of the internal muscle tension that has built up. Stability and tactile input can be given by using hard mattresses and flexion-abduction cushions (see ◘ Figs. 3.2 and 3.3). This results in being able to reduce the internal input and the possibility of more contact with the dementia patient.

3.6.7 Paratonia

Paratonia occurs in the last stage of dementia and is characterized by unconscious compliance or opposition by the patient to every form of passive movement. Paratonia is described as a form of hypertonia (Middelveld-Jacobs and Boogerd 1986) that for passive movements meets the following criteria:

1. Increase in muscle tones during passive movement of the extremities, the head, and the trunk. This increase occurs both on flexion and extension, independent of the starting point of the joints.
2. With rapid movement the resistance increases.
3. With slow movement the resistance is slight.
4. The degree to which the resistance occurs varies from slight to very intense.

When regarding dementia as a CNS disorder, the paratonias can be regarded as a central muscle-tone dysregulation, therefore as CMD. Relaxation can be brought about using certain techniques.

If a form of hypertonia is assumed (Middelveld-Jacobs and Boogerd 1986), it should be possible to restore this to a structural normatonia by using local techniques (e.g., massage). In practice this is not the case. An increase in muscle tone continues to be observable under the influence of passive movement. This argues in favor of paratonia as an expression form of central muscle-tone dysregulation.

Paratonia is responsible for a reduction in the quality of life. For this reason attempts to influence paratonias through physiotherapy must be examined critically (see ► Chap. 6).

3.6.8 The Van Der Brugge Method

Red, Yellow, and Green in Dementia

«Red, yellow, and green in dementia» is a method that was conceived by Frans van der Brugge in 2011. Since then, it has been adopted by various institutions in the Netherlands and been named the van der Brugge method. The method arose as a result of a fall prevention project.

Within fall prevention two issues are important: What are the internal capacities of the person and what is the influence of external factors? We describe both issues. Under external factors we include, for example, the layout of the house, the shoes, and the space in the bathroom but also the approach by the caregiver. Fall prevention starts with identifying that there is actually an increased risk of falling, so that the approach can be matched to that. Two questions therefore arise:

1. When is there an increased fall risk?
2. Who should identify that that there is an increased fall risk?

To determine an increased fall risk, the physiotherapist has clinimetry to hand that can indicate whether there is indeed an increased fall risk. An increased fall risk is, among other issues, dependent on a number of factors that can be measured, including:

- Balance
- Strength
- Fitness
- Walking speed

Standard values are available for all these tests, so that it is quite easy to determine whether there is an increased fall risk.

There are however also a number of other factors that you must take into account as a physiotherapist, because these factors also have a negative influence on the fall risk. These include:

- Cognition
- Vision
- Polypharmacy

The physiotherapist is responsible for mapping out all these points, and he is also responsible for transmitting this information to the caregivers who are dealing with the people on a daily basis. The caregivers should also be able to identify when there is an increased fall risk, so that they can match their approach strategy to that. Within this method, fall prevention also means that prevention stands for being able to identify who is at risk of falling.

This method uses the colors green, yellow, and red. Green means no fall risk, and yellow and red indicate a fall risk. The residents of a psychogeriatric unit are all assigned a color. This color is determined on the basis of a screening by the physiotherapist, who using clinimetry determines how great the fall risk of the patient is. The classification has been defined as follows:

- Green: no fall risk present, the people can move around within the unit at will.
- Yellow: increased fall risk, but the fall risk has been accepted. The existence of an acceptable increased fall risk has been discussed with the family of the resident. The resident can move around the unit freely.
- Red: an increased fall risk that is also accepted, but where it is no longer justified because the fall risk, and possibly also the fall frequency, is very high. This is frequently in the period prior to the last phase in which the patient is wheelchair bound and bedridden. When that moment is reached, someone becomes much less likely to fall, possibly only when during transfers.

The Alzheimer's patient will experience mostly cognitive problems in the first period (green and no fall risk), after that slight motor problems (yellow and therefore a fall risk), and in later stages severe motor problems, which eventually lead to becoming wheelchair bound and bedridden (red and therefore a lower fall risk, except for the transition from still being able to walk to being wheelchair bound).

The colors are shown clearly and visibly for the care staff on the unit, for example, by placing a yellow photo frame at the door, a green sticker on the handover sheets, or a red highlight in the EPD (electronic patient dossier). Through this system the care staff know the color associated with the patients, because they are faced with this on a daily basis and are therefore informed of who has a high fall risk and who does not. This makes acting preventatively more effective and easier to apply.

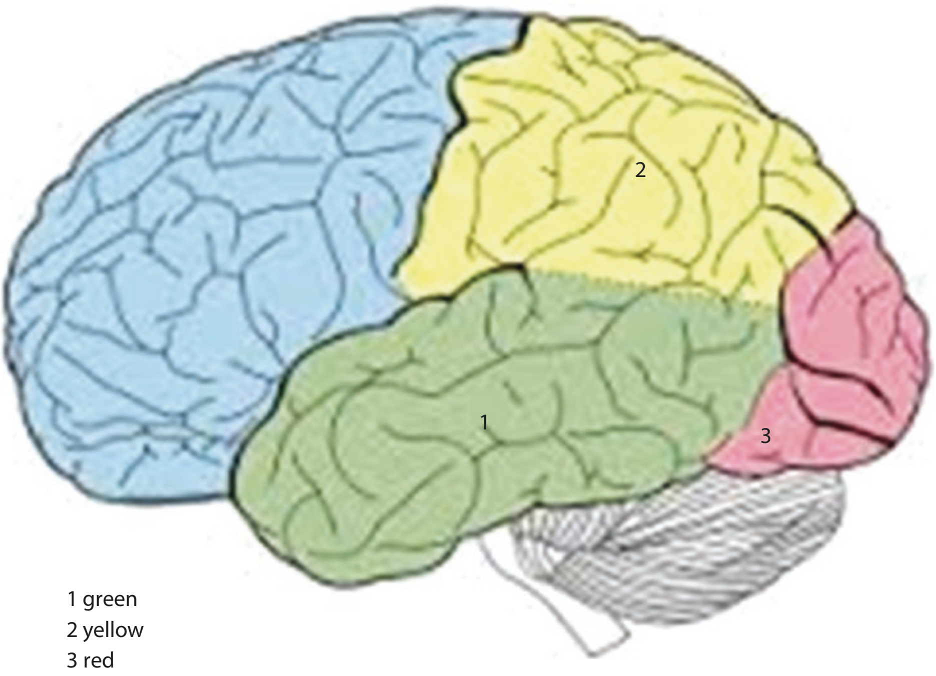
However, we have given the colors a further significance (see below), with which we can gain more advantages in the care process surrounding the dementia patient.

3.6.9 The Course of Alzheimer's Dementia

Thanks to the work of Dick Swaab, we know a lot about Alzheimer's dementia, for example, what course it will take in many cases. The order in which the regions of the brain and their accompanying functions are lost is generally as follows:

- Temporal
- Frontal
- Parietal
- Occipital
- Cerebellar
- Brain stem

If we also show that in terms of the colors, we see the following pattern (shown simplistically) (◘ Fig. 3.4).



◘ **Fig. 3.4** Order in which the functions are lost

These different regions of the brain all have specific functions, and these therefore are lost as Alzheimer's dementia expands. If we reverse this, we can also work out which will remain intact for the longest and which of the feedback systems we can best address in order to offer an Alzheimer's patient the best possible quality of life.

When we add the colors green, yellow, and red to Reisberg scale, that looks as follows.

Stage	Loss of skills	Color
Stage 1 No cognitive decline and normal functioning	Not applicable	Green
Stage 2 Very mild cognitive decline The patient himself experiences decline, and surroundings do not	Forgetfulness with regard to names, appointments, or where belongings have been put away Subjectively experienced word finding problems No objective proof for problems in complex activities, such as work	Green
Stage 3 Mild cognitive decline or the beginning of dementia «The threatened me»	Perceptible problems in activities Orientation problems in unknown surroundings Routine actions are intact (e.g., cooking)	Green
Stage 4 Moderate cognitive decline and emerging Alzheimer's dementia	Observable problems in ADL, such as grocery shopping, cooking, and organizing something Self-care is intact	Green or yellow
Stage 5 Moderate to severe cognitive self care decline and further progressed Alzheimer's dementia «The lost me»	Difficulty with simple elements of self-care With stimulation and incidental help, self-care is adequate	Yellow
Stage 6 Severe cognitive decline and advanced Alzheimer's dementia «The sunken me»	Self-care declines in phases (see below) Problems with dressing (praxis) Help needed to get in and out of the bath Inability to visit the toilet independently Double incontinence	Red
Stage 7 Very severe cognitive decline and end-stage dementia	Speech and simple motor skills decline Fetal position is adopted *Generally in the following order* Vocabulary <6 words Understandable vocabulary at the most one word Loss of walking function Is no longer able to sit up straight The ability for (spontaneous) expression disappears Is no longer to hold head up straight	Red

We can then link the physiotherapy interventions that are important in the successive phases to the colors green, yellow, and red.

Color	Therapeutic interventions	Argument
Green	Fitness training	Scientific studies have shown that the degree of progression can be slowed by this
	Balance training	
	Strength training	
	Stimulate spending the day in a meaningful way	
Yellow	Fitness training	See above Posture correction and mobilizing exercises, because you know which problems are going to occur in the red stage; by anticipating this you can defer this as long as possible
	Balance training	
	Strength training	
	Stimulate spending the day in a meaningful way	
	Posture correction	
	Mobilizing exercises	
Red	Mobilizing techniques for the prevention of unnecessarily painful contractures	Studies have shown that: Pain is a very frequent phenomenon in dementia patients With mobilizing techniques you can bring about temporary effects
	Mobilizing techniques to allow care to be given more easily	
	Advice about repositioning	
	Advice with regard to transfers	

For the nursing staff, the colors also provide clarity. The next chart indicates where attention must be paid within the care tasks and which have to be stated in the care plans.

Colors	Care aspects that can be taken into account	Argument
Green	Allow to do as much as possible in terms of personal care	Scientific studies have shown that the degree of progression can be slowed by this
	Stimulate spending the day in a meaningful way	
	Give tasks and responsibilities, if possible; examples are laying the table, clear the table, the mail, etc.	
	Stimulate participation in physical and social activities	
	Offer structure in the weekly program	

Colors	Care aspects that can be taken into account	Argument
Yellow	Allow to do as much as possible in terms of personal care, if possible	See above In this stage it is important to remain walking as long as possible, because it is known that the red stage is characterized by being wheelchair bound and/or bedridden
	Stimulate spending the day in a meaningful way	
	Give tasks and responsibilities, if possible; examples are laying the table, clear the table, the mail, etc.	
	Stimulate participation in physical and social activities	
	Offer structure in the weekly program	
	Allow to walk as much as possible under supervision, if possible	
Red	Decubitus	The red stage is characterized by an increasing invalidity that leads to immobility and thus to being wheelchair bound and/or bedridden; because of this there is an increased chance of the named symptoms It is advisable in this final stage to focus the entire treatment process on comfort for the patient
	Lung infections	
	Increasing contractures	
	Pain	
	Problems with swallowing	
	Incontinence	
	Comfort and possibly implementation of PDL	

Briefly summarized the «van der Brugge method» involves the following:

- The colors green, yellow, and red are assigned to residents of a psychogeriatric unit so that the caregivers know precisely who is at risk of falling and who is not.
- Physiotherapy interventions can be linked to the colors (see chart).
- Agreements can be made within the care process about which focus areas belong to which colors.

Symptomatology in Practice with MS

F. van der Brugge, *Neurorehabilitation for Central Nervous System Disorders*,
DOI 10.1007/978-3-319-58738-7_4

4.1 Introduction

Similarly to ► Chap. 3, this chapter will also deviate from the classification used in ► Chaps. 1 and 2. The reason is that with multiple sclerosis (MS), no distinction can be made into primary impairments and secondary impairments. The symptoms are, namely, entirely dependent on where the sclerotic plaques arise. The localization of the sclerotic plaques defines the symptomatology that occurs as a result of MS. It is a syndrome with a great variety of symptoms. The occurrence of exacerbations is typical of MS. These can occur with variable frequency. It is important to introduce treatment interventions that have a positive influence on reducing these exacerbations. Medication and good harmonization of burden and resilience help to reduce the number of exacerbations.

If we look at the symptomatology, we see many commonalities with the other CNS disorders, such as spasticity, fatigue, slowed information processing, depression, etc. Of course this provides starting points for uniform treatment interventions in the case of CNS disorders, without losing sight of the uniqueness of the individual.

The chapter has been structured as follows: firstly the causes of MS are discussed and subsequently the prevalence and diagnosis. In ► Sect. 3 the different forms of MS are discussed and then the symptomatology of MS. Finally, in ► Sect. 5 the imbalance in the burden and resilience as a consequence of socio-emotional problems will be discussed.

4.2 Causes of MS

Multiple sclerosis (MS) is an autoimmune disease. The most important characteristic of an autoimmune disease is that the immune system attacks healthy cells. The myelin sheath becomes damaged as a result of inflammations. The myelin sheath ensures that information is conducted by the nerves without interference. It is comparable to receiving various stations on the television. The coax cable passes on the information, so that the images from the stations can be received in high resolution. When the insulating layer around the cable becomes damaged and the wires inside become damaged, the images you receive in your living room become hazy. This is what also takes place with MS. Initially the flow of information is problem-free, but demyelination causes interference in the nerve conduction, and the information is not passed on smoothly. Studies have shown that in MS patients, it is not only the myelin sheath that is damaged, but in the longer term, the actual nerves are also damaged. This is called axonal damage. Frequently that is the indicator that a relapsing-remitting MS is changing to the secondary progressive form (Teunissen and Vereijken 2007).

At the places where the inflammation has damaged the myelin, hard sclerotic plaques form (◘ Fig. 4.1 and 4.2). This results in a reduced nerve conductance.

A substantial number of studies have been conducted worldwide into the causes of MS, but as yet only «pieces of the puzzle» have been found. Viruses and genetic disposition may play a role in the occurrence of this autoimmune disease. It is, however, becoming clearer that early treatment can limit the damage to the body.

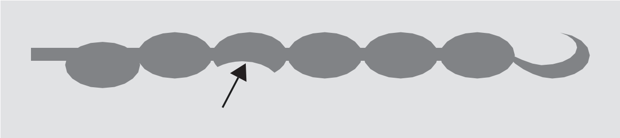


Fig. 4.1 Inflammation on the myelin sheath and the development of sclerotic plaques (Source: R. Hoof)

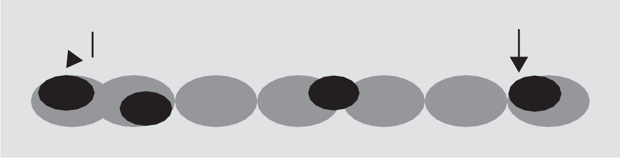


Fig. 4.2 Sclerotic Scars

4.3 Prevalence, Diagnosis, and Classification of MS

The diagnosis of MS is generally made in people aged between 20 and 40. Women have twice as likely to develop MS as men. There is no test with which MS can be diagnosed directly. The diagnosis is made on the basis of the anamnesis, the symptoms, and the presentation of the symptoms. Apart from these clinical data, an MRI scan, a liquor test, or *visual evoked potentials* (the response speed to a visual stimulus is measured and that provides information about the function of the eye nerve) can ultimately confirm the diagnosis of MS. The following aspects are of critical importance when making the diagnosis:

1. The symptoms and clinical signs must correspond with abnormalities in the white substance of the eye nerve, brain, or spinal cord.
2. The symptoms and abnormalities must point to multiple localizations in the central nervous system.
3. The symptoms and abnormalities must have occurred in at least two episodes (relapsing-remitting) or must have been progressive over at least a period of 6 months.
4. The complaints and abnormalities cannot be explained by another cause (for these additional investigations are frequently necessary).

A physiotherapist must be informed of this clinical diagnosis. In practice he regularly has patients reporting these symptoms. When these symptoms are recognized, which frequently occur in a certain chronology, the physiotherapist can decide to refer the patient to a specialist.

Patients with MS are classified according to the EDSS (*Expanded Disability Status Score*). The classification is as follows:

0	Normal neurological findings
1	No disability, minimal signs in one functional system
2	Minimal disability in one functional system
3	Moderate disability in one functional system; however, still able to walk without help (fully ambulatory)
4	Can walk 500 m without help but has serious disability in one functional system (gradual transition to the secondary progressive form)

5	Ambulatory without help or a rest pause at 200 m, but disability is too severe to be able to work full time
6	Needs a walking stick, crutch, or walking aid to walk 100 m, with or without rest pause
7	No longer able to walk more than 5 m, even with help; wheels self in wheelchair and can get in and out of wheelchair
8	Bedridden or chairbound, good use of arms, but needs help with transfer from/to chair/bed
9	Helpless bed patient, can communicate and eat
10	Dead as a result of MS (seldom)

The EDSS provide the opportunity to assess the course of the MS in the longer period.

4.4 Different Forms of MS

In spite of the variation in and the unpredictability of the symptoms, there is with MS a certain consistency in the way in which the disease behaves over the long term. MS is traditionally subdivided into three categories: relapsing-remitting, secondary progressive, and primary progressive MS.

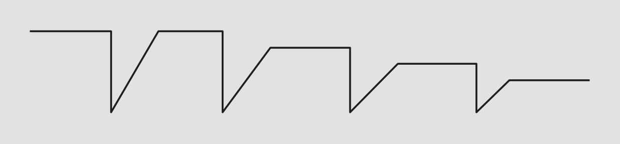
4.4.1 Relapsing-Remitting MS (30–40% of Patients)

This form of MS is characterized by the frequent exacerbations that occur and by the ever-reducing level of functioning that the patient unfortunately experiences.

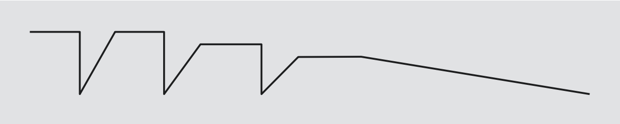
4.4.2 Secondary Progressive MS (Approx. 40% of Patients)

What is conspicuous about (◘ Fig. 4.3) is that it is identical to that of the relapsing-remitting form of MS but that in the end it takes a chronic progressive course. This is explained by the fact that axonal damage occurs over time (Teunissen and Vereijken 2007), and because of this the adaptation space decreases. That means that the axonal damage and the accompanying reduced adaptation space cause the MS to gradually become progressive (◘ Fig. 4.4).

◘ Fig. 4.3 Schematic illustration of the course of relapsing-remitting MS



◘ Fig. 4.4 Schematic illustration of the course of secondary progressive MS



◘ Fig. 4.5 Schematic illustration of the course of primary progressive MS

This form of MS arises following the relapsing-remitting form of MS and is known as the secondary progressive form of MS. There is also a form of MS that is gradually progressive right from the first exacerbation. This form is known as the primary progressive form of MS (◘ Fig. 4.5).

4.4.3 Primary Progressive MS (10–20% of Patients)

In the primary progressive form, the disease worsens continuously, and eventually certain functions and abilities are permanently lost. In this group of patients, severe and multiple impairments arise within a short time.

4.5 Symptomatology of MS

In view of the damage that inflammation lesions cause to the myelin in various places in the CNS, there is a very large variation in symptoms with MS. The following symptoms can occur: exacerbations, vision problems, sensation impairments, loss of strength, coordination impairments, spasticity, fatigue, pain, problems with the bladder function, and cognitive function impairments.

4.5.1 Exacerbations

Exacerbations are very characteristic of MS. The various forms of MS are classified by means of these exacerbations. An exacerbation is described as the occurrence of flares in existing neurological symptoms or of new neurological symptoms, not accompanied by fever, with a minimum duration of 24 h. It is also known as a schub or relapse.

Following the occurrence of these exacerbations, the level of functioning is affected. Much study has been done into the influenceability of exacerbations. Provoking factors are infections and hormonal changes (in women post-menstrually). Overweight, poor sleep, stress, and being overtired seem to provoke exacerbations as well. The MS patient must build some daily living rules into his daily schedule, so that these factors are reduced to a minimum.

Example from Practice 4.1

Mrs. J. was diagnosed with MS 6 years ago. Recently the relapses have been increasing in frequency, in spite of the medication she has been prescribed for this. In the last year, she has had no less than three major relapses. Each time she has gotten worse. She has a relapsing-remitting form of MS. Because she has been well informed, she knows that the time has come to implement daily living rules in her ADL. She is motivated to do this, because otherwise her MS could progress to being secondary progressive MS.

The PROP daily living rules, as are also used within cognitive rehabilitation for CVA, stand for:

- Pause: to avoid overtiredness as much as possible.
- Regularity: maintain your routine on good days as well as less good days.
- One thing at a time: to prevent stress as much as possible.
- Pace yourself: to reduce both stress and overtiredness.

It is not easy for Mrs. J. to keep to this, but she does her best and is still motivated. The reason for this is that she notices that she is getting something out of it; for example, she has more energy. Sometimes on days when she is feeling good, she is trying to do all sorts of things at the same time. She has to pay for it with a couple of not-so-good days, but she feels it is worthwhile.

Prevention of exacerbations can also be supported medicinally. It is known that the relapse frequency can be reduced by an average of 30% by using immunomodulating therapy (Filippini et al. 2003). These are drugs that suppress the inflammation reactions that are the result of the abnormal functioning of the immune system in MS. This results in less damage to the myelin sheath taking place. Interferon beta-1b and glatiramer acetate are used for this. Mitoxantrone, a drug used mostly in the treatment of cancer, suppresses the immune system and is reserved for cases of MS that are progressing rapidly, such as primary progressive MS.

It is furthermore very important to intervene rapidly and adequately during an exacerbation. When there is an exacerbation, attempts can be made to positively influence recovery by using corticosteroids. These drugs do not affect the degree of recovery achieved but rather the speed with which improvement is obtained.

Exacerbations lead in both relapsing-remitting MS and secondary progressive MS to reduced function. After each exacerbation the patient has to find the motivation to once again attain the highest feasible level and to keep going until the following exacerbation and so on. Insight into motivation models is important here too, because the physiotherapist has to provide care, time after time, for someone who has lost some functionality.

Example from Practice 4.2

The first time I found myself affected by multiple sclerosis was on a sunny day in June. I became very tired while playing tennis and suddenly could no longer see properly with my left eye. I could not longer see some things and colours were dull and vague. When I looked to the side, I felt a stinging pain behind my eye.

I went to the doctor, who referred me eventually to a neurologist in the hospital. He told me that I had I neuritis optica (inflammation of the optic nerve) and that my vision would fully recover. I looked it up in a medical book and discovered that neuritis optica can be the first symptom of MS. At my next appointment with the neurologist I asked him. He confirmed that there was a chance that I might develop MS, but for the same money I could have no further symptoms. What I had read in the book about MS was extremely depressing and when I went home, I was very frightened and felt very alone with my fear. I told myself that nothing else was going to happen to me. For the outside world I acted as if there was nothing wrong, but inside I was scared to death of getting MS and becoming handicapped.

I didn't want to know that I had MS and so I no longer went to see the doctor.

About 4 years after I had the first problems with my eye, I couldn't use my right hand and arm any longer. I noticed that, for instance, I couldn't hold my car keys and frequently dropped them. It also took me a lot of effort to hold a cup of coffee with my right hand. If I didn't look at it, I'd spill coffee. I was ashamed and preferred not to be in company for fear of making myself look ridiculous.

When the symptoms got worse, I went back to the neurologist and he made the diagnosis: MS. To be honest, I was relieved that I finally knew for sure what was wrong with me. I had to learn to live with my illness. That wasn't easy, but I managed and I felt better. About a year later I became very depressed after yet another relapse, when I found I could no longer walk properly. Another setback. (Source: Account from the author's own practice)

4.5.2 Vision Problems

As was indicated in ► Example from Practice 4.2, vision problems (neuritis optica) are frequently the first symptom, and they often prove to be a forewarning of the eventual diagnosis of MS. The occurrence of an inflammation and demyelination at the level of the optic nerve lies behind these symptoms. The vision problems disappear but are followed by other symptoms of MS.

4.5.3 Sensation Impairments

- More gnostic impairments than failure of vital functions.
- Paresthesias, such as burning sensation and itch.
- Conspicuous in MS: Lhermitte's sign. When the neck is flexed, there is a sudden sensation as if an electric shock is running down the back to the legs.

In many cases, these symptoms (vision problems and sensation impairments) are the first to be experienced in combination with a feeling of fatigue never previously experienced. It is described as general fatigue and a heavy feeling in the legs. If these two symptoms are the first to manifest, the prognosis is more favorable than when the disease emerges with initial complaints related to the brain stem or cerebellum. The course is then more aggressive.

4.5.4 Loss of Strength

People with MS often experience loss of muscle strength. In almost half the patients, the disease starts with muscle weakness, irrespective of the aforementioned symptoms. This is a prominent symptom especially with the primary progressive form. Sometimes it occurs abruptly; generally it is a gradual process. It starts with a tired feeling in the legs, and later normal daily matters such as walking and cycling become more difficult. At a later stage, paralysis can even occur. Generally there is paresis and the ability to tense the muscles is still present. This is crucially important when making transfers.

4.5.5 Coordination Impairments

When the disease first appears with initial symptoms related to the brain stem or the cerebellum, the prognosis is less favorable. Coordination impairments are often an expression of the presence of sclerotic plaques in the cerebellum or brain stem.

Example from Practice 4.3

Mrs. G. has never actually had symptoms. She has always felt really healthy until she had a heavy feeling in her arm for a couple of days.

In that couple of days, it developed into a situation where she is no longer able to control her arm properly. When eating she finds herself sticking her fork in her lip, and when she's trying to pick something off the table, she often knocks over a glass – something that never happened to her before.

Two weeks later, walking is also not going so well. She can get around everywhere independently, but she has to pay good attention and watch that she's putting her feet down properly.

These turn out to be the first symptoms of MS, with the first symptoms coming from the cerebellum. Within a year she is ataxic and walks with a walker. At home she doesn't use her walker, because she knows the route and knows where she can hold on. She has adapted cutlery for eating. Her voice is also no longer what it was: there's a crackle in it and talking is much slower than it used to be.

Unfortunately her relationship has ended and she now faces the future alone.

4.5.6 Spasticity

The pattern of muscle weakness as a result of MS is often accompanied by spasticity and muscle stiffness. This spasticity is the consequence of impairment in the transmission of stimuli between the motor cells in the spine on the one hand and those in the brain on the other hand. As a consequence, primitive spinal cord reflexes occur that can lead to an enormous increase in tension in the extremities. This occurs mainly in the legs; this is in contrast to the spasticity or paratonias that we see with, respectively, CVA and dementia. These forms of muscle-tone dysregulation are caused by a lesion in the brain.

The possibilities for influencing spasticity and muscle stiffness are discussed in ► Chap. 7.

4.5.7 Fatigue

Fatigue is a major problem with CNS disorders and also with MS. Many patients indicate experiencing limitations to how they function because of it. Fatigue is also reported to provoke exacerbations. Positive influence of this is therefore an important starting point for the physiotherapy intervention. The introduction of daily living rules (see ► Example from Practice 4.1) constitutes a key instrument for influencing fatigue. Other starting points will be discussed in ► Chap. 7.

◘ **Table 4.1** Symptoms of MS and the degree to which patients experience that symptom as the main symptom

	Number of patients who experience this symptom (*N* = 316)	Number of patients who experience this as their main symptom (*N* = 316)
Bladder or bowel problems	59 (19%)	18 (6%)
Cognitive problems	16 (5%)	–
Depression	155 (49%)	7 (2%)
Eyesight ↓	173 (55%)	24 (8%)
Fatigue	59 (19%)	18 (6%)
Mobility ↓	279 (88%)	114 (36%)
Pain	316 (100%)	110 (35%)
Spasms	40 (13%)	2 (1%)
Problems with swallowing	6 (2%)	1 (< 1%)
Others	46 (15%)	

4.5.8 Pain

Pain is a fact with MS. In the study that underlies ◘ Table 4.1, 100% of the patients reported it as a symptom that was present. Different numbers have been found in other studies. We can conclude that it is a very frequent symptom with MS. There is a relation between the pain and the degree of spasticity present.

4.5.9 Problems with Bladder Function

Abnormalities in bladder function originate in impaired control from the brain to centers in the spinal cord. The sphincter muscle of the bladder is a voluntary control muscle. When there is an increase in the spasticity of the legs, the bladder sphincter muscle also sometimes becomes involved. That means that this muscle is more difficult to relax. Urination is thus hampered and urine retention occurs. This results in an increased risk of urinary tract infections, and that can have annoying consequences.

Example from Practice 4.4

Mr. W. has developed a urinary tract infection. He has not catheterized himself properly in the last few days, as a result of a party and two overnight stays elsewhere. He is really fed up, because the urinary tract infection has had some very serious consequences. He has pain, the spasticity in his legs has increased because of this, and to make things worse, this means he can no longer get out of bed on his own. Getting dressed is more laborious, and ultimately the transfer from bed to his wheelchair is only just successful but is not certainly without danger.

This whole situation makes him dependent on his wife, and she has to go to work as normal. That therefore means getting up early, and that costs him his badly needed rest. In short, he's kicking himself that he didn't catheterize properly.

An impaired bladder function can also show up in a different way, where the urine stream is often interrupted during urination. This is caused by fluctuations in the spasm of the sphincter muscle. Using medication can influence the spasticity and bring about better voiding of the bladder. This produces a considerable reduction of urinary tract infections.

4.5.10 Cognitive Function Impairments

Cognitive function impairments, such as memory problems, slowed information processing, and less concentrated attention, are associated with MS. It does however depend on where the sclerotic plaques develop. The named cognitive function impairments very probably do not provide a complete overview of what can happen in this area in the MS patient. Good insights into the function impairments that can occur on the basis of lesions in the brain (see ► Chap. 1) are necessary. It is a prerequisite to be able to recognize cognitive function impairments. When the presence of cognitive impairments is suspected, it is possible with imaging techniques to visualize a confirmation of the suspicion.

4.6 Imbalance in Burden Versus Resilience as a Result of Socio-emotional Problems

Just like Parkinson's disease and dementia, MS is a progressive disease. Yet other factors are at play here with regard to socio-emotional problems. The MS patient is, namely, generally younger and has a different future perspective. Where the Parkinson's patient generally already has completed his working life, those with MS sometimes still have to start. This often leads to this group having to go the extra mile to make themselves attract to an employer in the labor market and has an irrevocable influence on the burden-resilience model. This often leads in practice to difficult situations.

Example from Practice 4.5

Mrs. B. has a nice job. She works as a clerk at a large garage company, from 9 am to 2 pm daily. Recently it has been getting busier and busier, and there's a backlog of work. They can't employ anyone extra, because that is too expensive. Mrs. B. has been asked if she could work for longer. She decides to do it and nowadays she works from 8.30 am to 4 pm.

For the first few weeks, things go pretty well, but when she gets home, she's very tired. She has no energy to cook and is going earlier and earlier to bed. Her husband is beginning to complain. At work, there is no longer the same atmosphere because everyone is really busy with their work. They have to work really hard and there's not much time for a coffee and a chat.

She's finding it more and more difficult to get up on time, and work has really become a burden. When she gets, she is irritable. That's also true of her husband. He also has a busy job and he's on his last legs. For weeks he's been doing all the grocery shopping, cooking, and managing the rest of the household.

The burden is too high for both of them and their resilience is still reducing.

After 4 months Mrs. B. has a relapse and finishes up on sick pay. After 3 weeks she has recovered a bit and she can go back to work. She has the feeling that she has to give in to something. What she'd really like is her old working hours back, but her boss wants her to keep working 8:30 am to 4 pm. She faces a difficult choice: perhaps she'll suffer another relapse, and she'll have to accept she can do less again.

The unpredictability of the occurrence of the exacerbations and their frequency mean that it is difficult for the MS patient to settle on a fixed future expectation. It creates anxiety and tension. How the person deals with this uncertain future depends on his character and on his coping skills. What is certain in the case of a progressive disorder such as MS is that finding a balance between burden and resilience is an ongoing process.

5

Commonalities of Various CNS Disorders Shown Schematically

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The title of this book, *Neurorehabilitation for Central Nervous System Disorders*, implies, among other things, that there are common paramedical goals within the different CNS disorders. These are defined on the basis of treatable variables. As previously indicated, the title of this book, *Neurorehabilitation for Central Nervous System Disorders*, implies, among other things, that there are many common symptoms among the different CNS disorders. This makes it possible to set up uniform treatment interventions. This justifies the use of the term neurorehabilitation (= rehabilitation for neurological disorders) in the title.

◘ Table 5.1 indicates the symptomatology frequently seen in CNS disorders. If there is a plus (+), this indicates that there may be impairments in the named item. That does not mean therefore that when there is a plus that it will be present in every patient with that pathology.

The table includes references to the chapters or sections in which the items concerned are discussed in more detail.

From ◘ Table 5.1 it can be concluded that there are many commonalities between the various CNS disorders.

◘ **Table 5.1** Symptomatology of central nervous system disorders

Symptomatology	**CVA**	**Parkinson's disease**	**Dementia**	**MS**
Functions				
Coordination	+	+	+[a]	+
Agility	+	+	+[a]	+
Stamina	+	+	+[a]	+
Muscle strength	+	+	+	+
Speed	+	+		+
Sensation (▶ Sect. 7.2)	+			+
CTD (▶ Sect. 7.3)	+	+	+[a]	+
Neuropsychological function impairments (▶ Sect. 7.4)				
Attention	+	+	+	+
Orientation	+		+	
Perception	+		+	
Memory	+	+	+	+
Language/speech	+	+	+	+
Executive functions	+	+	+	
Praxis	+	±	+	
Information processing	+	+	+	+

■ **Table 5.1** (continued)

Symptomatology	**CVA**	**Parkinson's disease**	**Dementia**	**MS**
Activities (▶ Chap. 9)				
Self care	+	+	+	+
Transfers	+	+	+	+
Walking	+	+	+	+
Social participation	+	+	+	+
Various (▶ Sect. 7.5)				
Pain	+		+[a]	+
Fatigue (▶ Chap. 8)	+	+	+	+
Depression	+	+	+	+

[a] Later stage

Examining a Patient with a CNS Disorder

F. van der Brugge, *Neurorehabilitation for Central Nervous System Disorders*,
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Summary

The following common symptomatology is typical of a CNS disorder and therefore frequently present in the case of CVA, Parkinson's disease, dementia, and MS: (1) impairments in coordination, flexibility, stamina, strength, and speed; (2) sensation impairments; (3) central muscle-tone dysregulation (CMD); (4) cognitive problems; (5) chronic fatigue; (6) presence of depression; (7) an impairment in one or more feedback systems; and (8) imbalance in burden versus resilience. This means that, with respect to neurorehabilitation, a uniform strategy may be applied to the common symptomatology. This chapter explains how the physiotherapist can obtain information about this symptomatology.

6.1 Introduction

Below is a list of which common symptomatology is typical for a CNS disorder and thus often present more in the case of Parkinson's, dementia, MS, and a CVA:

- Impairments in the coordination, flexibility, stamina, strength, and speed(CoFSSS)
- Sensorimotor impairments
- Central muscle-tone dysregulation (CMD)
- Cognitive problems
- Chronic fatigue
- Presence of depression
- An impairment in one or more feedback systems
- Imbalance in burden versus resilience

This means that, with respect to neurorehabilitation, a uniform strategy may be applied to the common symptomatology. This chapter explains how the physiotherapist can obtain information about this symptomatology.

► Chapter 7 will explain which interventions are available to get the patient with a CNS disorder functioning at as high a level as possible.

6.2 CoFSSS

6.2.1 Coordination

The cerebellum's functions include acting as the control center for coordination of random muscle activity, balance, and muscle tonicity. To be able to perform these three important functions, the cerebellum has to receive constant feedback from:

- The position of the muscle and joints and the muscle tone
- The balance
- The cortical impulses that go to the muscle

Integration of these elements allows the cerebellum to coordinate and control the movements. Although coordination is not the same as is balance, we define coordination in the context of CoFSSS as balance. Balance is the ability to maintain one's balance in changing situations, and to do this, well-coordinated control of the various muscle groups is essential (◘ Fig. 6.1).

Fig. 6.1 MRC 4

On the other hand, it is also possible that the control from the cerebellum is adequate but that the muscle tension or, for example, the propriocepsis is not sufficient.

Coordination/balance is assessed with the *Berg Balance Scale* (BBS) and/or the *timed get up and go* (TUG).

6.2.2 Flexibility

What is meant by flexibility is the mobility in the joints, also known as the range of motion (ROM). An attempt must be made to try and establish which structure is responsible for the mobility restriction, because that determines what can be influenced and to what extent by physiotherapy interventions; see ► Chap. 7. Structures involved are:

- Myogenic contractures: through the catch and springy end feeling
- Collagen contractures: full length not attainable and stiff end feeling
- Neurogenic restrictions: recognizable from the loss of mobility in combination with stimuli elsewhere
- Osseous restrictions: severe contractures and a hard end feeling («bone on bone»)

You can determine mobility with a protractor or with a classification rising from a slight mobility restriction to a severe restriction in the mobility of the joint.

6.2.3 Stamina

Stamina is essential to be able to persist in doing certain activities. We can test this in several ways, whereby the «6-min walking test» and the Åstrand cycle test are the most commonly used.

6.2.4 Strength

The added value of strength assessment by means of the Medical Research Council Scale (MRC) in patients with CNS disorders is dubious, particularly if there is a clear CMD present, which is manifested as hypo- or hypertonia. It is then probably better to test functional activities and to assess whether selective movements can be carried out. Selective movements are those movements that do not fit into the pattern that was described in ► Chap. 1.

In a number of cases, conducting a muscle test according to the MRC scale is appropriate, where one allows the patient to make the movement against a manual resistance of the physiotherapist. The following scale can be used:

- 5 = normal strength.
- 4 = the complete movement can be made but not against much resistance.
- 3 = the complete movement can be made against gravity.
- 2 = the complete movement can be made when gravity is eliminated.
- 1 = a contraction is observable but there is no movement.
- 0 = total paralysis (◘ Fig. 6.2).

◘ **Fig. 6.2** Impaired balance and control reactions

It is also possible to conduct a 1-RM test or a 10-RM test. This will be further clarified in the next chapter in ► Sect. 7.2.

6.2.5 Speed

In terms of exercise physiology, the last S in CoFSSS stands for speed. Within this professional field, this is formulated as the speed at which a joint can pass through a number of degrees.

We can also formulate this as speed but then as the walking pace. Studies have shown that a walking pace of higher than 2.8 km/h leads to greater social participation. It is thus absolutely worthwhile training walking pace, and it is certainly possible to do so. Walking pace is measured with the 10-m walking test (◘ Fig. 6.3).

◘ **Fig. 6.3** Walking pace is very important

6.3 Sensation Impairments

Sensation is very prominent in terms of evoking motor skills. For instance, when we pick up something, then we register within a fraction of a second how heavy it is, and then we immediately set the tonicity of our muscles to match. Thus that comes about within a non-impaired sensorimotor collaboration.

But what happens if one of the two is impaired or both? The chance of this is very real in the case of a CNS disorder. This leads irrevocably to an impaired movement pattern, and therefore it is extremely relevant to know which forms of sensation there are and how we can examine them.

6.3.1 Spinothalamic Tracts

This concerns examining exteroceptive sensation. This consists of:

- The sense of touch. The test is conducted by means of the person conducting the examination touching the patient's skin. The patient must indicate whether he can feel it. In a slightly more specific form of this test, you could ask the patient to indicate *where* he felt it, for example, on the lower arm, the thumb, etc. (◘ Fig. 6.4).

◘ **Fig. 6.4** Mr. P. indicates where he is being touched on the leg

- The pain sensation. The test is carried out with a blunt and a sharp object. The patient must indicate whether it is blunt or sharp. The sharp stimulus gives a pain sensation and thus indicates whether that system is intact. For ADL of a patient, that is an essential finding, because otherwise injuries or damage can occur without the patient being aware of that happening.
- The temperature sensation. The test to assess the temperature sensation is done using heat and cold. For this we use warm compresses and ice.

6.3.2 Spinocerebellar Tracts

This concerns examining proprioceptive sensation. This consists of:

- The postural sensation. The test can be conducted in several ways. You can place one of the extremities or part of it in a certain position and ask the patient whether he can place the other extremity in the same position. Another possible way is to ask the patient to take note of the position of which the limb is in. The limb is then moved a number of times, and the patient is then asked to place the extremity back in the original position. It thus concerns the static position of the limb (◘ Fig. 6.5).

◘ **Fig. 6.5** Bringing the arm back into the same position with closed eyes

- The movement sensation. This test can also be conducted in various ways, with the aim of determining whether the dynamic movement sensation is intact. One way is to have the patient say «yes» as soon as part of the body is moved, for example, the thumb. Another way is, for example, to move the arm and ask the patient to move the other arm in the same way.
- The vibration sensation. This test can be done using a tuning fork. Make the tuning fork vibrate and place the end on a joint. Ask the patient to say «yes» if he feels it and then to say «stop» when you have stopped the vibrations in the tuning fork by grasping it with your hands and stopping it.

6.3.3 Extinction and Two-Point Discrimination

Extinction and two-point discrimination are also sensitive information systems:

- Extinction is the fact that whenever you give stimulation on one side, this is experienced, but when you do it on both sides, the information (stimulation) is only perceived on one side. This does not need, by definition, to be only with tactile information but can also occur when there are too many stimuli in the surroundings. The excess stimulation means that not everything is observed.
- Two-point discrimination is tested by giving two sharp stimuli, which can vary in force. At which force is it still perceived and when is it no longer perceived? An impairment in this function in the feet can lead to an unstable gait. On the other hand, an impairment in the hands can lead to the diminution of fine motor skills.

6.4 CMD

CMD stands for central muscle-tone dysregulation. Muscle tone can be defined as the degree of resistance (or the lack thereof) that is experienced with passive movement of an extremity, the head, or the trunk. Muscle tone is tested passively by moving the joints and being alert to the resistance that you experience in the muscles. You do this initially at a slow pace and then you do it more quickly. You pay attention, when doing this, to the myotatic reflex that can be caused by the acceleration.

The degree of resistance is shown on the Ashworth Scale:

1. No increase in muscle tone.
2. Slight increase in muscle tone with a catch during flexion or extension.
3. More marked increase in muscle tone, but the limb can still be bent or straightened easily.
4. Marked resistance, passive movement is difficult.
5. The limb is rigid in flexion or extension.

All these forms of hypertonia are called spasticity and are generally observed in the antigravity muscles. Thus means the flexors of the arms and the extensors of the legs.

CMD is a specific characteristic for a CNS disorder and has many forms in which it is expressed. The following list gives some of the names used for an excess of muscle tone.

Parkinson’s	Rigidity
MS and CVA	Spasticity
Dementia	Paratonia

When there is CMD, this inevitably has an unfavorable effect on the variation, stability, and possibilities of motor coordination.

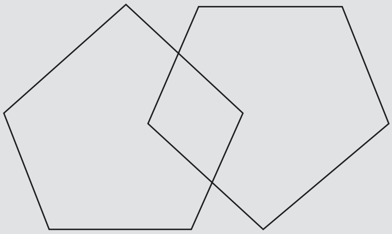
6.5 Cognitive Problems

Another specific characteristic of a CNS disorder is that there can be cognitive function impairments. This is assessed by a neuropsychologist, but in order to obtain a clinical picture when cognitive problems are suspected of being present, it is advisable to conduct a *Mini-Mental State Examination* (MMSE).

MMSE (Mini-Mental State Examination)
Name: ___________________________
Date of birth: ______________________
Date of examination: __________________

Instructions
I am going to ask you a few questions and ask you to solve a few problems to check your memory and concentration. Most questions are easy. (Score one point for each correct response within each question or activity.)

Question	Maximum score	Patient's score	Questions
1	5		«What is the year? Season? Date? Day? Month? »
2	5		«Where are we now? State? County? Town/city? Hospital? Floor? »
3	3		The examiner names three unrelated objects clearly and slowly, and then the instructor asks the patient to name all three of them. The patient's response is used for scoring. The examiner repeats them until patient learns all of them, if possible
4	5		«I would like you to count backward from 100 by sevens. » (93, 86, 79, 72, 65, ...) Alternative: «Spell WORLD backwards. » (D-L-R-O-W)
5	3		«Earlier I told you the names of three things. Can you tell me what those were? »
6	2		Show the patient two simple objects, such as a wristwatch and a pencil, and ask the patient to name them
7	1		«Repeat the phrase: «No ifs, ands, or buts. » »
8	3		«Take the paper in your right hand, fold it in half, and put it on the floor. » (The examiner gives the patient a piece of blank paper.)
9	1		«Please read this and do what it says. » (Written instruction is «Close your eyes. »)
10	1		«Make up and write a sentence about anything. » (This sentence must contain a noun and a verb.)

Question	Maximum score	Patient's score	Questions
11	1		«Please copy this picture. » (The examiner gives the patient a blank piece of paper and asks him/her to draw the symbol below. All ten angles must be present and two must intersect) 

Explanation of the Questions

- 1 and 2 relate to orientation in time and place.
- 3 and 5 relate to imprinting and short-term memory.
- 4 relates to attention concentration and mathematics.
- 6 relates to the ability to link language and objects.
- 7 relates to the ability to reproduce a sentence.
- 8 and 9 relate to reading and the execution of tasks and linking action to execution.
- 10 relates to the ability to write and language comprehension.
- 11 relates to insight into the visio-constructive ability.

Interpretation of the MMSE

The functioning of the dementia patient before the illness manifested must be taken into account.

Method	Score	Interpretation
Single cutoff	<24	Abnormal
Range	<21 >25	Increased odds of dementia Decreased odds of dementia
Education	21 <23 <24	Abnormal for eighth grade education Abnormal for high school education Abnormal for college education
Severity	24–30 18–23 0–17	No cognitive impairment Mild cognitive impairment Severe cognitive impairment

Interpretation of MMSE Scores

Score	Degree of impairment	Formal psychometric assessment	Day-to-day functioning
25–30	Questionably significant	If clinical signs of cognitive impairment are present, formal assessment of cognition may be valuable	May have clinically significant but mild deficits. Likely to affect only most demanding activities of daily living
20–25	Mild	Formal assessment may be helpful to better determine pattern and extent of deficits	Significant effect. May require some supervision, support, and assistance
10–20	Moderate	Formal assessment may be helpful if there are specific clinical indications	Clear impairment. May require 24-h supervision
0–10	Severe	Patient not likely to be testable	Marked impairment. Likely to require 24-h supervision and assistance with ADL

Source: Folstein et al. (1975)

6.6 Chronic Fatigue

Chronic fatigue means that there is constant tiredness that is not caused by effort and that also does not disappear after resting. It occurs very frequently among patients being treated for CNS disorders and is reported to be the symptom that has the greatest impact on ADL. A possible way of tackling this chronic fatigue is described in detail in ► Chap. 8. Chronic fatigue can be assessed using the *Fatigue Severity Scale* (FSS).

6.7 Depression

Depression occurs more frequently among people with a CNS disorder than among people of the same age without this disorder. For this reason it is also good to be aware of this whether you are working solo or in a multidisciplinary team.

With patients with a CNS disorder, neuropsychological function impairments frequently occur, including problems with executive functions. This includes, for example, taking initiative. Often this lack of initiative is frequently attributed to the presence of a depression, but it can therefore also be attributed to an impairment in executive functioning. This last point can be compensated by drawing up a structured daily program.

In the case of a depression, further investigation is desirable. A questionnaire that can measure depression is the *Beck Depression Inventory* (BDI).

6.8 An Impairment in One or More Feedback Systems

A typical characteristic in the case of a CNS disorder is the presence of an impairment in one or more feedback systems. These feedback systems concern:

- Sensation
- Auditive perception
- Smell
- Taste
- Vision
- Cognition

As a physiotherapist you spend a lot of time with the patients practicing motor skills. When learning motor skills, motivation and feedback are essential for turning learning into a success. And it is precisely in the patient with a CNS disorder that the chance of an impairment in one or more feedback systems is very high. It is therefore necessary to investigate this in order to then be able to determine the right learning strategy. Which *feedback system* you address within the chosen learning strategy is very important. This is discussed in detail in ► Chap. 10.

6.9 Burden Versus Resilience

There can only be one conclusion drawn from everything in this chapter: The resilience of a patient is really put to the test by a CNS disorder. It is therefore very important to properly estimate the burden that one is placing on the patient with a CNS disorder. This is discussed further in ► Chap. 8.

Influenceable Functions and Cognitive Rehabilitation

F. van der Brugge, *Neurorehabilitation for Central Nervous System Disorders*,
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Summary

In this chapter, the treatable variables and thus the starting points for neurorehabilitation are described. In patients with a CVA, Parkinson's disease, MS, and dementia, the symptomatology may restrict functioning. Interventions relating to mobility, muscle strength, stamina, sensory system, balance, spasticity, and cognitive rehabilitation form a starting point of the physiotherapy treatment and care of the patient with a CNS disorder. The physiotherapy care should contribute to improved general well-being and improved ability of the patient to function in his direct surroundings or in society. To assess the physiotherapy care you have offered, you must be able to make it measurable. Clinimetry is an important tool in terms of the physiotherapy care of patients.

7.1 Introduction

In this chapter, the treatable variables and thus the starting points for neurorehabilitation are described. In patients with a CVA, Parkinson's disease, MS, and dementia, the symptomatology may restrict functioning.

Interventions relating to mobility, muscle strength, stamina, sensory system, balance, spasticity, and cognitive rehabilitation form a starting point of the physiotherapy treatment and care of the patient with a CNS disorder.

The physiotherapy care should contribute to improved general well-being and improved ability of the patient to function in his direct surroundings or in society. To assess the physiotherapy care you have offered, you must be able to make that measurable (see for that also ► Chap. 6). Clinimetry is an important tool in terms of the physiotherapy care of patients.

An observation form, especially developed for patients with a CNS disorder, has been included in the appendix. The items described in this book are included in this observation form.

7.2 The CoFSSS

7.2.1 Coordination/Balance

Balance is the ability to maintain balance in changing situations. This is necessary in order to be able to function well in daily life. Studies have shown that people with a CNS disorder decline after an intensive period of rehabilitation in their ADL. This can be blamed in part of the fact that the activity level in the period without rehabilitation is less high. As a result of this muscle strength, stamina and balance, among other things, decline (Leroux 2005). Periodic treatment of this patient group could prevent a decline in functioning.

Box 7.1 Research into Functional Gain

Research conducted among 1197 ABI patients (acquired brain injury) shows a 95% functional gain in the first 12 weeks. Thereafter, there is, however, a decline in functioning as a result of reduced physical activity (Leroux 2005). This diminished functioning especially affects balance, walking, and ADL skills. This had a negative influence on the experienced *life satisfaction*.

In a study group where the ABI had been incurred at least 1 year previously, an 8-week exercise program was started. This consisted of working for 1 h on strength, balance, mobility, coordination, and ROM twice a week. The result was that after 8 weeks, significant progress had taken place on the timed get up and go (TUG) test, the Berg Balance Scale (BBS), and the Stroke Impairment Assessment Set (SIAS). There was also a positive influence on the experienced life satisfaction.

In studies conducted among ABI patients in a chronic stage, where the intervention was aimed at influencing the upper extremity, similar results were also recorded.

7.2.2 Flexibility/Mobility

Mobility restrictions occur frequently with CNS disorders. Studies have shown that in patients with a CVA that after 1 year there was an average increase in stiffness of 50% in the hemiplegic side (Kwakkel 1995a, b), as well as an increase in stiffness in the non-paretic side. Changes in contractility properties between actin and myosin and a change in the length of the sarcomeres are responsible for the increased stiffness. These are restrictions at the *myogenic* level.

Changed visco-elasticity and the formation of adhesion of noncontractile elements, such as tendons, fascia, and ligaments, are also responsible for the increase in stiffness. These are called the *collagen* restrictions.

In the case of the pathologies described, there can also be muscle-tone dysregulation (spasticity, rigidity, and paratonias), and as a result, it is difficult for patients to find the end positions of the joints. Consequently, the risk of myogenic and collagen contractures is clearly present. This has an effect on general functioning. Peripheral stiffness is more easily influenced by physiotherapy intervention than the centrally regulated spasticity. Preventing muscle stiffness is a starting point for physiotherapy intervention.

Finally, *neurogenic* restrictions can occur. Overstimulation of these structures causes pain, as a result of which any spasticity present can increase.

In ◘ Table 7.1, the various restrictions are described as well as the ways in which to differentiate which structure is responsible for the restriction and to what extent this is can be influenced.

Table 7.1 Mobility restrictions and degree of influenceability

Structure	End feeling	Strategy
Myogenic contractures	Through the «catch» and springy end feeling	Extending fully a number of times per day
Collagen contractures	Full length not attainable and stiff end feeling	Stretch for 6 h consecutively, 200 days (therefore splint)
Neurogenic restrictions	Recognizable from the loss of mobility in combination with stimuli elsewhere	Extend fully a number of times per day
Osseous restrictions	Severe contractures and hard end feeling	Surgical interventions if necessary

Box 7.2 The Practice

A good treatment strategy does not guarantee the prevention of contractures. However, it does legitimize your actions.

In practice you regularly see contractors occurring in one patient and not in another, despite using the same treatment strategy. Obviously there are intrinsic factors present that are co-contributors to the occurrence of these contractures.

For the team treating the patient, it is important to treat the patient in accordance with the «rules.» As a result, it actually becomes transparent that everything has been done to optimize the mobility that was necessary to achieve good functionality.

Myogenic Contractures

Myogenic contractures are easy to influence. Stretching to length a number of times per day is sufficient to exercise an influence on the visco-elastic properties of the myogenic structures. Muscle-mobilizing bed positions (within the NDT concept, these are discussed as spasm-inhibiting bed positions) can contribute to the prevention of myogenic restrictions. This is a key goal because when restoring function, sufficient muscle length is needed to be able to generate strength.

In the acute and subacute phase of a CVA, muscle-mobilizing bed positions and exercises form part of physiotherapy care. It is, namely, in that phase that the first problems appear in the myogenic structures. The majority of patients do not have any functional abilities in the arm in that phase. The physiotherapist is responsible for the policy aimed at prevention of myogenic restrictions. In the post-acute phase, auto-mobilizing exercises are taught, which are carried out a number of times per day by the patient himself.

Given that in patients with Parkinson’s, MS, and dementia (later stage), there is also muscle-tone dysregulation, seeking myogenic end positions in this patient population is also important. The aim is to prevent increases in contractures. There is, namely, a hierarchy in the ontogenesis of contractures, and that is the following:

Myogenic → neurogenic → collagen → osteogenic

Neurogenic Restrictions

Neurogenic restrictions run approximately parallel with the myogenic restrictions that can arise with immobility. Through the mobility restrictions, we find that gradual anatomical adaptations of the neurogenic structures occur. Prevention of this from occurring is important, because neurogenic restrictions can cause pain and paresthesias. To prevent these structures from shortening, the nerves have to be stretched several times per day (see ▣ Table 7.1).

Shortening or entrapment of these neurogenic structures results in overstimulation, the consequence of which is a radiating pain over the course of the nerve. Entrapment or shortening of this system can be recognized from the tension tests being positive (see ▣ Figs. 7.1, 7.2, and 7.3).

The following peripheral nerves are sensitive to changes and are tested for length.

Collagen Contractures

Collagen structures are less easy to influence than myogenic and neurogenic contractures. Influencing depends on consistent and long-term measures that must be taken. A mobilizing effect on collagen structures occurs when a strategy is implemented in which stretch is applied for 6 h consecutively for a period of 200 days to the structures that need to be lengthened. Night splints are one option. These must gradually have an ever-increasing mobilizing effect until the desired mobility is achieved (see ▣ Fig. 7.4).

Subsequently ankle-foot orthotics (AFOs) are fitted to retain the mobility achieved. The influence of a central neurological lesion is permanent.

Before taking these measures, it is best to discuss the goals with the patient in depth, because it is a long-term, arduous treatment.

▣ **Fig. 7.1** Nervus ischiadicus (sciatic nerve)

Fig. 7.2 Nervus medianus (medial nerve)

Fig. 7.3 Nervus ulnaris (ulnar nerve)

Fig. 7.4 Nervus radialis (radial nerve)

Osseous Restrictions

If there are osseous restrictions there, an operation is the only effective intervention. It is of essential importance to weigh up the pros and cons of a surgical intervention, because this entails additional risks in this patient population.

Example from Practice 7.1

Mr. S. had a motorcycle accident and was in coma for 5 weeks. When he regains consciousness, there appear to be severe central nervous system injuries. Naturally mobility restrictions have also manifested in the joints. In both hips there is a flexion contracture of 15°; as a result of which, the transfers and walking are severely impeded.

After a number of months of rehabilitation, the decision is eventually made to remove the PAOs (periarticular ossification) by means of an operation. One reason for only doing this at this stage was waiting to see what the effects were of physiotherapy. Moreover, an operation is not entirely risk-free given his comatose history.

The result of the operation is positive. As he now has a greater ability to extend in his hips, transfers are easier and walking has gained in efficiency.

7.2.3 Stamina

Training stamina has, just like training strength, not been the center of attention for a long time. The reason for this was that it was assumed that training stamina would be too intensive and that consequently spasticity would increase. Research has shown that this is not the case (Teixeira-Salmela and Olney 1999). The intensity of training stamina is often still an obstacle. In practice it appears, as it happens, that the assumption is made that intensive training is too much of a physical burden.

What Criteria Should Stamina Training Meet?

What applies here is that stimulation of 50% of the heart rate reserve (HRR) according to Karvonen is a good training stimulation. This is built up in the elderly to 75–80% of the HRR (Bemt and Mechelen 1998b). The Ästrand test is one instrument for determining the VO_2max (maximum oxygen uptake) and thus for assessing what is the starting point and whether after the training session any progress has been made.

Example from Practice 7.2

Mrs. K. is 66 years old and she has Parkinson's disease. The request for help relates to improving her stamina. On the Ästrand test, she has a score of 23, which corresponds to moderately fit.

For the first 2 weeks, she spends time getting used to cycling with a heart rate monitor. In this period, we do that at a heart rate of 40% of Karvonen. This is calculated as follows:

- Resting heart rate is 73
- Maximum heart rate is 220–66 (age) = 154

40% of Karvonen then means 73 (resting HR) + 40% of (154–73) = 105. We are going to build this up gradually to 75% of Karvonen and a duration of 20 min per training session. Increasing the resistance will increase the heart rate.

After 8 weeks of training, we repeat the Ästrand test, and this time Mrs. K. scores 28, which corresponds to reasonably fit. This motivates her to keep going, because apart from the improved score, she also shows improvements on the Patient-Specific Functional Scale measured with the aid of the VAS. She is less rapidly tired and therefore can do more.

Arguments in Favor of Stamina Training

On the basis of biological aging processes, the VO_2max declines as from the 30th to 50th year of life by 1% per year. After the 50th year of life, this is even faster. This can be improved by about 15% by good training (Bemt and Mechelen 1998b).

People with a CNS disorder generally have less motivation to undertake activities. This results in an accelerated decline in stamina. A study among CVA patients showed that training stamina leads to a reduction in blood pressure and to improvements in muscle strength (NHSS 2001). Training stamina also has also a positive effect on the aerobic capacity, measured with the Ästrand test.

As stamina is easily influenced, training stamina is certainly a starting point for treating people with a CNS disorder.

7.2.4 Strength

For a long time, strength training was counter-indicated in CNS disorders. The reason for this was the assumption that the degree of spasticity would increase through strength training. During the training, there are associated reactions and movements in synergistic patterns. After finishing training, these disappear immediately.

Studies have however shown that there is no increase in spasticity as a result of strength training (Teixeira-Salmela and Olneyl 1999). There was not only improvement in function, but the patients also scored better at a functional level. The results of the study also showed an increase in gait speed and improvements in the fluidity of movement when walking.

What Criteria Should Strength Training Meet?

If the intention is to improve muscle strength, then as a minimum a strength stimulus has to be administered of 50% of 1 RM, that is the maximum weight that someone can lift in one go. Because this is very difficult to determine, a number of repetitions equate to a certain percentage of 1 RM (◘ Fig. 7.2). The fewer the repetitions the patient can make, the more accurate the estimation test. In ◘ Table 7.2, you can see what the maximum weight is that someone can lift in one go. It is possible to draw up a training program on the basis of these values. With elderly persons, you work toward a strength stimulus of 75 to 80% of 1 RM (Bemt and Mechelen 1998a).

◘ **Table 7.2** Table that can be used to draw up a program for strength training

Number of repetitions	3–5 repetitions ≈ 90% of 1 RM	8–11 ≈ 80% of 1 RM	12–22 ≈ 70% of 1 RM	20–30 ≈ 60% of 1 RM
Test weight in kilograms	**Therefore, 100% equates to**	**Therefore, 100% equates to**	**Therefore, 100% equates to**	**Therefore, 100% equates to**
5	6	6	7	8
10	11	13	14	17
15	17	19	21	25
20	22	25	29	33
25	25	31	38	42
30	33	38	43	50
35	39	44	50	58
40	44	50	57	67
45	50	56	64	75
50	56	63	71	83
55	61	69	79	92
60	67	75	86	100
65	72	81	93	108
70	78	88	100	117
75	83	94	107	125
80	89	100	114	133
85	94	106	121	142
90	100	113	129	150
95	106	119	136	158
100	111	125	143	167
105	117	131	150	175
110	122	138	157	183

Example from Practice 7.3

Studies have shown that strength can be vastly increased in the elderly. The reason for this is that the elderly frequently starts at a lower starting point. Imagine you are training a top sportsman; he has already put in such a massive amount of work on training that he is probably at the ceiling of his motor skills. The elderly person is not and certainly not if there is a CNS disorder.

Mr. P. is 74 years old and has a CNS disorder. He has never played sports, and since he has had this CNS disorder, he has been less active. The request for help made by Mr. P. is to improve his walking.

Using the leg press 1 RM of the quadriceps is determined. He can push a weight of 50 kg. If we look at ◘ Table 7.2, eight repetitions correspond to 80% of 1 RM. If we look further in the table, 1 RM should correspond to 63 kg.

When drawing up a training program, you always start with a familiarization period of 2 weeks with the elderly. You do this because they can then work on their technique on the leg press. The training starts with 50% of 1 RM; this means with a weight of 30 kg. You make three series of 12 repetitions. This is then gradually built up in increments of 2 weeks, i.e., 55%, 60%, up to 75–80% of 1 RM.

In between it is important to assess what the 1 RM is at that moment, because you may assume that the strength is increasing.

In this way training can provide an improvement in the function. It is important to know whether the patient is experiencing functional progress. This can be assessed using the Patient-Specific Functional Scale questionnaire and the VAS (visually analogue scale). In this the patient indicates three activities that he would like to see improved. Using the VAS, a score can be determined at the start in respect of satisfaction with the activities concerned. After 6 weeks, an improvement in the function can be expected, and the progress on the 1 RM and the Patient-Specific Functional Scale can be measured (see ◘ Fig. 7.5).

Three Arguments in Favor of Strength Training

1. As a result of biological aging processes, muscle strength decreases. Between the 30th and 70th year of life, strength decreases by 30%. After the 70th year, this decline is more rapid and can be 10% per decade. Because most people with a CNS disorder are elderly, these processes play a role in the occurrence of muscle strength loss (Bemt and Mechelen 1998a).
2. People with a CNS disorder generally have less motivation to undertake activities. Because of this there is an accelerated decline in muscle strength.
3. It has been demonstrated that spastic muscle tissue is weakened. There are, namely, fewer fast-twitch fibers (type 2) that can be recruited; as a result of which there is effectively loss of muscle strength (Kwakkel 1995a, b).

Through these three negative influences on muscle strength on the one hand and easy influenceability of muscle strength on the other side, training muscle strength is certainly a starting point for the treatment of people with a CNS disorder. It is certainly true now that it has been demonstrated that there is no unfavorable effect on spasticity and training leads to improvements at the activity level (Teixeira-Salmela and Olney 1999).

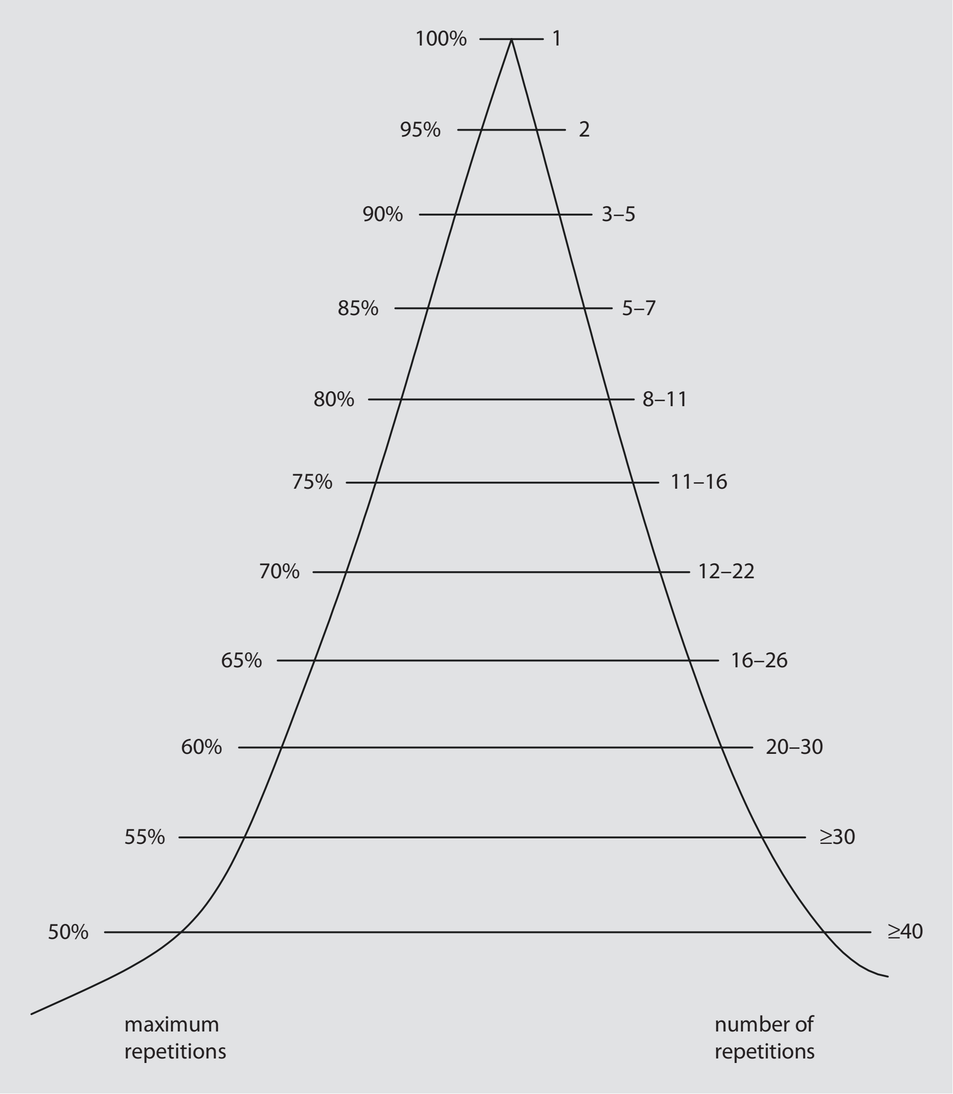

Fig. 7.5 Tool for drawing up a program for strength training

Real-Life Example

The exercises in the functional training circuit are aimed as much as possible at those ADL skills that take more effort as one gets older:

1. Getting up from a chair
2. Dressing and undressing
3. Reaching above the head
4. Carrying a shopping bag
5. Walking up- and downstairs

These are the five stations that are included in the training program. At each station, three repetitions must be done. Each repetition consists of 30 s of effort (on a Borg Rating of Perceived Exertion (RPE), scale rated between 11 and 14) followed by 1 min of rest. After the third repetition, the heart rate is measured and noted. The patient then moves to the next station.

The rest period can be extended as necessary during the training circuit because the patient recovers more slowly.

The heart rate is always noted to get an indication of the training intensity of the program. If it is difficult to work with heart rate, the Borg RPE scale can also be used.

It is useful in the period prior to starting the 6-week program to conduct the Berg Balance Scale, the 10-m timed walking test, and the 6-min walking test minimally two times per week. This is done after the program finishes to assess changes.

7.2.5 Speed

As previously formulated, we define speed in a different manner to the terminology of exercise physiology. Within the CoFSSS, speed is defined as walking pace in neurorehabilitation. Walking pace is a very relevant starting point, because a speed of over 2.8 km per hour contributes to improving the social participation of the client.

What 2.8 km per hour means on the following clinimetry (as a lower limit) is:

- 10-m timed walking test takes 12.9 s.
- 6-min walk test – the distance covered is 280 m.

7.3 Sensation

Sensation, subdivided into spinothalamic and spinocerebellar sensation (see ► Sect. 6.3), is a very important feedback system (see ► Chap. 1) that enables us to learn skills. Without sensory feedback, it is more difficult to learn a motor skill.

If there are sensory problems as a result of a CNS disorder, it is important to stimulate that sensory system as much as possible, because there is possibly some form of residual capacity, and this contributes to the sensorimotor integration of the stimulated areas. If this is not sufficiently effective, then other feedback systems must compensate for the lack of sensory information, for example, the visual system.

There is not much known at present about the effect of training the sensory systems; this is in contrast to strength and stamina. A search on PubMed with search terms «stroke and somatosensory therapy» and «CVA and somatosensory therapy» produced the following results.

- **Study 1**

(Johansson et al. 2001) A group of 150 CVA patients were selected 5–10 days after the CVA and divided in three groups:

1. Group 1 received acupuncture and electroacupuncture.
2. Group 2 received sensory stimulation with low-frequency transcutaneous electrical nerve stimulation (TENS) with high intensity; as a result of which muscle contractions occurred.
3. Group 3 was the control group and received high-frequency electrostimulation with a low intensity.

All patients were treated 20 times over a 10-week period. The researchers examined the differences in changes in motor function, ADL, walking abilities, social activities, and the degree of satisfaction with the treatment.

There appeared to be no advantage to being treated with acupuncture or TENS when compared with the control group.

Note: No sensory results were measured!

- **Study 2**

(Cambier et al. 2003) A group of 23 CVA patients was divided in two groups:

1. The experimental group ($n = 11$) received intermittent pneumatic compression therapy (ten series of 3 min) on the hemiplegic arm in addition to the standard physiotherapy treatment.
2. The control group ($n = 12$) received a placebo treatment, namely, shortwave therapy, on the hemiplegic shoulder for the duration of 30 min in addition to the standard physiotherapy treatment.

The somatic sensation (investigated with the Nottingham Sensory Assessment Scale) improved after the treatment in both groups. However, it was more improved in the experimental group ($p = 0.036$).

Note: Small study group!

- **Study 3**

(Voller et al. 2006) In patients with somatosensory impairments after a CVA, a nerve block was applied to the good hand. In healthy test persons, this led to an improvement of the tactile discriminative skills in the other hand. This result was also measurable in the CVA patients.

A nerve block in the foot resulted in no improvement in sensation.

Note: There is no description of the persons tested and no description of the sensory test used.

From this we can conclude that there is not much good research into the effects of specific sensation training. Many somatosensory studies are focused on motor outcomes and not on the sensory systems. The studies that were focused on sensory outcomes were conducted on small study groups.

The Dutch Occupational Therapy Guideline on Stroke 2005 indicates that few studies have been conducted into the prevalence of somatosensory problems in combination with their significance in real life. Assumed causes for the small number of studies aimed at improving sensation in CNS disorders are:

1. A lack of validated and reliable measurement instruments with which sensation can be tested in a clinically simple manner in patients with a CNS disorder.
2. Investigation of sensation can be hampered by the possible presence of problems with perception, comprehension, or communication.
3. Fatigue and reduced concentration can play a role and have a negative influence on the tests.
4. Possibly the researcher's interpretation of the client's response is incorrect.

From the studies that have been conducted, it can be concluded that the applied interventions have contributed to the stimulation of sensorimotor integration. As this feedback system is very relevant for the acquisition or monitoring of skills, it is worthwhile making the effort to stimulate the sensory systems. If this has little effect, then obviously other feedback systems must engage to compensate for the loss of sensation .

7.4 CMD

Central muscle-tone dysregulation (CMD) as a result of a CNS disorder is expressed in a variety of forms. In MS and CVA patients, we see spasticity as a manifestation of the muscle-tone dysregulation that is present; in Parkinson's patients, it occurs as rigidity, and in patients with dementia, we call it paratonias.

In the era of the NDT concept, spasticity was the most important item in respect of the rehabilitation of CVA patients. For many years, the inhibition of spasticity was seen as a goal, with the aim of generating normal motor skills. Empirical evidence has shown meanwhile that the existing spasticity cannot be structurally influenced by means of physiotherapy interventions.

Now that we know that spasticity and the accompanied changed movement patterns cannot be influenced by physiotherapy interventions (Den Otter et al. 2006), we should ask ourselves what place spasticity occupies within the rehabilitation of people with a CNS disorder. The degree of spasticity does, in fact, have a restrictive influence on general functioning (see ◘ Fig. 7.6).

◘ **Fig. 7.6** In spite of the severe central muscle-tone dysregulation, a lot is still possible

The following aspects are important when considering influencing spasticity:

- Feasibility of functional gain
- Pain reduction
- Optimizing the ability to care for the patient
- Optimizing nocturnal sleep

7.4.1 Spasticity

There are several ways of influencing spasticity. The treatment possibilities are described below.

▪ Physical Techniques

The use of a wrist orthotic with electrical stimulation is a physical technique whereby electrical impulses are given by means of electrodes. This causes the extensors of the fingers and the wrist to alternate between tensing and relaxing. The purpose of this is to move the muscles out of the spastic pattern and thereby achieve a positive effect on the degree of spasticity. The muscle contractions thus created bring about local processes that have a preventive effect on the worsening of the existing contractures. The contractions stimulate the contractility properties of the musculature and the risk of a collagen restriction considerably lower (see ► Sect. 7.2.2).

▪ Oral Medication

Antispasmodics are prescribed with the aim of influencing undesirably high spasticity. One disadvantage of this form is that the medication enters the blood stream and is therefore absorbed by the entire body. Because of this, its effects are felt not only in the place that one wants to influence, but they can also be observed elsewhere in the body. These side effects can cause general fatigue and muscle weakness elsewhere in the body. This can have an influence on daily living.

Example from Practice 7.4

Mrs. F. has MS. An examination has revealed a severe form of spasticity in the trunk and legs. She has a great deal of willpower. She is able to make the transfers on her own and at home she uses a walking stick. This is not without danger, but for her it is a way of fighting against the decline.

After experiencing influenza, she has become weaker and is no longer able to walk with a walking stick. The spasticity is unchanged, but through the increase in weakness, she is barely able to move her legs anymore. The proposal is to influence the spasticity with oral medication so that she will be able to have more selectivity in her legs while walking. The assumption is that she will be able to move her legs more easily as a result.

After 2 weeks of oral medication, she is still unable to move her legs. Even worse, it is taking her more effort. For example, holding the walking stick in her hand and putting weight on it is very difficult. She feels general weakness. The decision is made to gradually discontinue and stop her medication.

After 5 weeks of practicing and practicing walking with a walking stick, she achieves her goal. She is able to use a walking stick at home. This time she won the battle against the functional decline.

Intrathecally Administered Medication

The group of patients that qualifies for intrathecal baclofen therapy (ITB) are those with a serious generalized form of spasticity of the trunk and legs. They have experienced no positive effects from oral antispasmodics. The spasticity hampers them in their general functioning. A pump is implanted under the skin of the abdomen, which is filled with baclofen, which is delivered into the fluid around the spinal cord (intrathecal space). This local administration is much more effective in controlling the spasticity. There is an improvement in the ability to care for the person concerned and in making (independent) transfers.

Neurosurgical Treatment

Selective dorsal rhizotomy (SDR) is an operation in which selective sections of the nerve root in the spine are severed. When there is severe spasticity of the legs, for example, a portion of the sensory nerves that are responsible for tensing these muscles are severed during a surgical intervention, allowing the spasticity to reduce. The operation takes place on the lower back. It is a major surgery that lasts between 4 and 6 h and is frequently carried out on children. It is a less common procedure for adults, and because of this, little is known about the effects of SDR on the various CNS disorders.

Orthopedic Interventions

In the context of treating spasticity, the split anterior tibialis tendon transfer (SPLATT) procedure) is a new development. With this form of tendon transposition, half of the still active musculus tibialis anterior is detached from its attachment points, the os metatarsale I and the os cuneiforme mediale. This is then repositioned to the outside of the foot and attached to the os cuboideum or the musculus peroneus tertius. This results in a correction of the varus tilt, which in turn provides an improvement in the gait. The indications that the patient must satisfy to qualify for this operation are:

- Muscle strength of 4 measured in the pattern in the musculus tibialis anterior
- Varus tilt of the foot during the swing phase
- Sufficient passive mobility in the ankle joint

Nerve and Muscle Blocks

For nerve blocks, phenol is injected and this is therefore known as phenolisation. This substance is injected into the peripheral nerve or in the motor nerve end. The purpose of the injection is to ensure that the nerve can no longer pass on its information, and as a result, it has a paralyzing influence on the spastic musculature.

An injection with Botox is another intervention that is more selective. With this method, a substance is injected (derived from *Clostridium botulinum*) into the muscle that one wants to influence. This substance creates a block for acetylcholine. This is the substance that is needed to pass on the stimuli that brings about a muscle contraction. The block has a paralyzing effect on the spastic musculature. The patient will be able to use the agonistic muscles better and through exercising will develop better gait or improved hand function.

The possibilities of influencing spasticity – varying from local to generalized and from reversible to irreversible – are shown schematically in ◘ Fig. 7.7.

This diagram shows that there are many ways of intervening to influence muscle-tone dysregulation. Ideally the choice would be made in a multidisciplinary setting. Following treatment for spasticity, follow-up treatment is actually frequently needed, in which both occupational therapy and physiotherapy are involved.

Box 7.3 Botox and Orthopedic Cast Correction

Within pediatric rehabilitation, an injection with Botox has already been used for several years to influence spasticity. Following the Botox injections, orthopedic cast correction can be applied bilaterally for a period of between 2 and 6 weeks. The aim is to influence the structures around the ankle. It is a walking cast and the children are told to walk, walk, and walk while they wear the cast. Thus, proprioceptive information is being used from a corrected position of the feet.

After removal of the cast, the next stage is physiotherapy at least four times a week and occupational therapy treatment twice a week for 10 weeks.

After this period, the treatments are continued but at lower frequency. The physiotherapist monitors the ROM attained and trains strength, balance, and stamina. The occupational therapist focuses on applying what has been learned in functional situations, like dressing and undressing, transfers, walking outside, etc.

In the future, Botox injections will be possible within neurorehabilitation for CNS disorders.

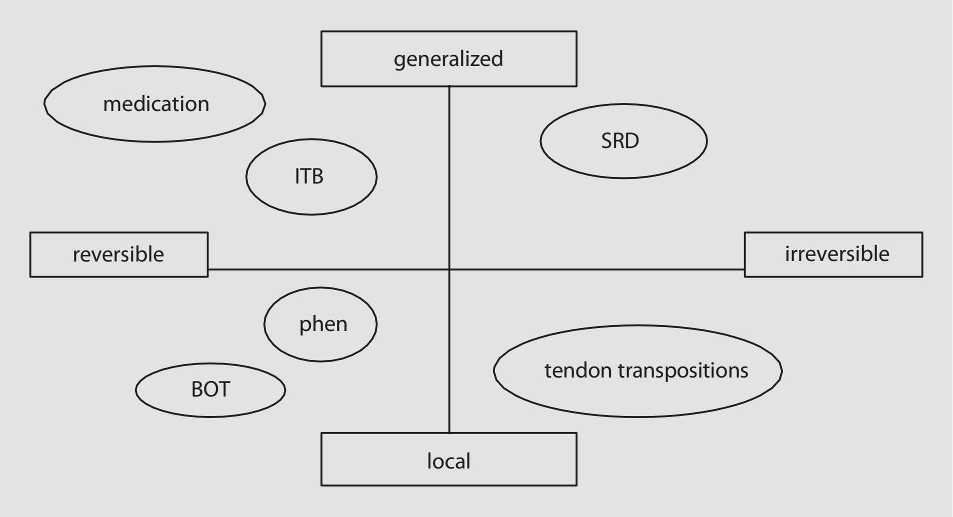

Fig. 7.7 Possibilities of influencing spasticity

7.4.2 Rigidity

Rigidity is a form of muscle-tone dysregulation that manifests in both the agonist and the antagonist. There is a higher tone in the flexors than in the extensors. The rigidity can be observed on passive movement; there is a resistance to both flexion and extension, the so-called lead pipe phenomenon. The muscle-tone dysregulation is provoked by accelerated movement, and a more jerky resistance can be felt, the «cogwheel phenomenon.»

The influence of rigidity on active movement has not been established in scientific research. Expertise about this is therefore based on empirical facts. It is assumed that rigidity is the cause of the inertia in actions.

Rigidity can increase under the influence of stressors, such as speed, fatigue, pain, and stress. These must be avoided as much as possible. This seems, as yet, to be the only option for achieving a positive effect with respect to the rigidity.

- **Paratonias**

Paratonia occurs in the last stage of dementia and is regarded as a form of hypertonia, which is characterized by unconscious collaboration or thwarting by a patient of any form of passive movement (Middelveld-Jacobs and Boogerd 1986). It can be regarded as a form of muscle-tone dysregulation as a consequence of a CNS disorder (see ► Chap. 3). In literature, several causes of these paratonias are considered:

1. It is thought that it could be a perception impairment; as a result of which, elevated muscle tone is built up, with the aim of generating more information.
2. A neurophysiological explanation states that the paratonia is a consequence of an impairment in the basal ganglia, in the frontal lobes, or in a combination of the two.
3. Paratonias can be considered as a direct consequence of damage to the central nervous system. In the meantime, it has become known that this can be accompanied by muscle stiffness and change in muscle lengths, which are jointly responsible for the impaired posture regulation. These changes are especially seen in impairments that have existed for more than a year. Research has shown that biomechanical changes such as muscle stiffness play a role in paratonia (Hobbelen 2004; Hobbelen et al. 2003).

Up to the present, there are few studies that show that physiotherapy interventions can be effective in respect of the course of the paratonias. However, there are indications that passive movement and pillows that offer good support do have an impact on the degree of paratonia.

- **Conclusion**

The forms of muscle-tone dysregulation that are caused by a CNS disorder do demonstrate a number of commonalities. In spasticity, rigidity, and paratonias, stressors can be identified that have an unfavorable influence on the degree of tone dysregulation. These stressors include:

- Fatigue
- Rapid movement
- Stress
- Pain

Identifying and recognizing the stressors provides starting points for the positive influencing of muscle-tone dysregulation as a result of a CNS disorder. In other words, making gentle movements, managing stress, reducing pain, and choosing a good starting position are the key to influencing the degree of muscle-tone dysregulation. The muscle-tone dysregulation is in itself a typical symptom of a CNS disorder that cannot be structurally influenced by physiotherapy intervention.

7.5 Cognitive Rehabilitation

Cognitive rehabilitation has become standard in caring for patients with a CNS disorder. The cognitive functions and impairments, just like the emotional and behavioral problems, are an important component of the rehabilitation intervention. This is intended to reduce the cognitive impairments that have arisen to a minimum. This aim can be achieved, in other words, in the case of permanent functional impairments, by enlarging the insight of the patient and his system. In addition it is possible to attempt to exercise a positive influence on the patient's daily life by teaching him strategies and offering him aids.

Before drawing up a treatment strategy within the field of cognitive rehabilitation, neuropsychological tests are needed to establish what is going on. Neuropsychological function testing includes the following components: provision of information about impairments in cognition, emotion, and behavior, additional tests or needs assessment for further testing, and the description of how the patient experiences the impairment.

Provision of Information

Providing information to the patient and those closely involved about the impairments in cognition, emotion, and behavior reduces the risk of asking too little or too much. This can prevent or remove unnecessary major worries. In practice it appears that it is necessary to have frequent repetition and to talk regularly about the information. Check whether the patient and those closely involved have understood the information and whether the relevant information has come across properly.

Additional test or needs assessment for further testing.

Example from Practice 7.5

Mr. C. has had a walking function impairment for about 15 months. This came about after a fall with his bicycle on a lovely summer day. The next morning he was sore all over, and he had a bad headache.

The atypical gait has not improved even after intensive physiotherapy, and he was eventually referred to a orthopedic specialist. He confirmed an abnormal gait, but was unable to indicate any cause. The patient is a scaffolder and a walking function impairment means he no longer feels confident.

There is a suspicion that he is profiting from his illness, because since his fall he has been on sick pay.

The psychologist was called in to help, and he determined that the patient had cognitive problems that could be related to a left hemisphere lesion. Slowed information processing, slight word-finding problems, and a reduced focused attention were observed. From the heteroanamnesis, it becomes clear that after the fall there was short-term aphasia. After neuropsychological testing, a post-contusional picture was confirmed. This provides a different perspective to the therapeutic approach to these symptoms.

Description of the Perception of the Impairments

The perception of cognitive restrictions is an important co-contributing factor for the general functioning of the person concerned and is important when it comes to establishing the treatment goals and choosing a learning strategy. Someone who overestimates their own ability will need to be slowed down.

Patients with cognitive restrictions can also underestimate themselves and limit themselves in how they function. A good insight into which functions are intact is essential; it indicates what potential capacity is present. The patient can be reminded of that and that can be quite motivating.

Example from Practice 7.6

Mrs. H. has suffered a substantial, diffuse infarction. The symptomatology is very extensive. This includes a hemianopsia, the propriocepsis on the right side is impaired, and there are perception impairments. What she regards as the worst problem is the presence of word-finding impairments, and because of this, she does not like leaving home. Imagine if she bumped into someone and that she could not say what she wanted to again.

She is practicing a lot with the speech therapist, but there is no real improvement in her spontaneous speech. However, if associations are made, such as nonverbal gestures or feeling the object with her right hand, then she can come frequently up with the words. Photos are also supportive and that is what is going to be applied in the real world.

A language pocket book will be created. Photos of bakery products, cold meats, milk products, etc. are stuck in. If she does not manage to say it herself, she can make an association with the photo, and then she is able to say it. This proves, after much practice with the occupational therapist, to be a good aid to allow her to shop on her own. At the beginning it was difficult, but she experiences it as positive. Things are going well and gradually Mrs. H is getting out and about regularly. Her radius of action has expanded and she has the necessary social contacts.

■ Recommendations with Respect to Treatment

The recommendations are based on concrete research data, obtained from neuropsychological function research. Within the various CNS disorders, there are, in terms of cognition, many commonalities in the impairments that can occur. For this reason, it is worthwhile knowing about a number of general recommendations that can improve the functioning of the patient with cognitive problems. These general recommendations are listed in ◘ Table 7.3. Generally the cognitive impairments occur as a mixture of impairments, and they cannot be regarded as independent of each other. For this reason, it is important to observe whether the patient with his typical problems can benefit from the recommendations that have been made.

The success of the recommendations is in part determined by the insight of both the patient and his close circle in the existing problems.

■ Evaluation of Treatment, of the Natural Recovery, or of Progressively Increasing Retardation

Repeated neuropsychological function testing provides, in the case of a CNS disorder, an indication about the recovery of functions. It can also provide information about the degree of progression of the disorder. This applies to MS, dementia, and Parkinson's disease disorders that are progressive in nature.

■ Contribution to the Prognosis

Good information and improving the insight of the direct system reduces the chance on stresses within this system. This is an important factor with respect to the general functioning of the person with a CNS disorder. Generally speaking, a couple's relationship or the family bond is more resilient when confronted with a physical limitation (e.g., an amputation) and then when facing cognitive dysfunction.

If the patient is still working, providing insight into the neuropsychological function impairments to the employer and his colleagues can play an important role in the functioning of the person with neuropsychological function impairments. It can contribute to normalizing excessively high expectations on the part of the employer and colleagues.

Table 7.3 General recommendations for how to improve the functioning of patients with cognitive problems

Cognitive impairments	General recommendations
Attention problems	Low-stimulus environment Ask someone pay attention Be aware of the noise in the background and avoid that as much as possible Create one-to-one situations Keep eye contact
Reduced memory	Use reminders Write down information for the patient Repetition of information Diary training Check whether information is understood and is remembered
Slowed information processing/language and aphasia	Use short and simple sentences Check whether someone can follow it and/or has understood Insert breaks on time Allow someone to quietly finish talking and do not complete yourself
Executive functions	A structured daily routine supports undertaking activities Diary use that contains the «duties» of the day Give feedback on success experiences
Fatigue	There is no cognitive limitation, but reinforces the cognitive impairments Try to find out when someone functions the best Use PRET; see under «Modification of Task and Surroundings»

Example from Practice 7.7

Mr. L. has a very good employer. He has been to speak with the neuropsychologist several times. He wants to set up the situation at work so that the chance of success is greater when Mr. L. starts coming back to work. For many years, Mr. L. has been a highly valued employee of the company.

The most limiting problem is Mr. L.'s slowed information processing. Attending meetings will be difficult because of this. The decision is made to have a one-to-one conversation after the meeting in order to repeat the most important items. He gets the minutes of the meeting the next day, so that he can go through everything once again at his own pace and provide his views.

Another sequela of the CVA is fatigue that arises more quickly. It is decided to build in an hour's rest into each day. Also the program for the week is known on Mondays. By doing this, he is trying to avoid as much stress as possible and not provoke the fatigue.

It is a successful tactic and Mr. L. is still a valued employee of the company despite his cognitive limitations. Now, after a year and a half, he can sometimes deviate from his usual habits without experiencing any problems.

7.5.1 Contents of Cognitive Rehabilitation

The aim of cognitive rehabilitation is to learn to work around the cognitive impairments that exist – and not to pursue the restoration of cognitive function. For this, it is very relevant that the patient has an insight into the cognitive limitations that exist. Once there is insight, the patient can be taught to use a strategy to work around or compensate for these shortcomings at the cognitive level.

Cognitive rehabilitation consists of the following items:

- Information and explanation
- Cognitive function training
- Skills training
- Strategy training
- Behavior modification
- Adaptation of tasks and surroundings

▪ Information and Explanations

Providing information and explanations to the patient and his immediate circle is essential in a good rehabilitation process. Firstly, explanations are aimed at providing insight into the consequences of the cognitive problems. Without this insight, there will, namely, be no solutions for problems caused by the reduction in cognitive functions. Secondly, through providing information and explanations, it is possible to avoid patients and their immediate circle having too high or too low expectations. Without good information, there may be over- or underestimation, which can lead to unnecessary stresses and does not contribute to a favorable prognosis.

▪ Cognitive Function Training

Cognitive function training, whereby an improvement in daily functioning serves as a measure of effectiveness, has proven to be rather disappointing until now (Fassoti 2005). The computer is often used as a training tool. What is then seen is that whereas someone scores better on the trained function, there is no generalization of what has been learned to the ADL. One advantage of cognitive function training is that the patient gradually gains an insight during this computer training into the limitations he has. As described above, that is a precondition for actually achieving successful cognitive rehabilitation.

▪ Skills Training

With skills training, the cognitive disability is accepted, and we try to teach the patient the skill through repetitive training by means of a systematic approach. For the skills training, a number of techniques are available including:

1. *Errorless learning*:
    - If a patient has no access to the explicit memory, errorless learning is advisable. Errors once learned are difficult to eliminate. This is in contrast to learning from errors: then you assume that there is sufficient feedback on own actions and that the patient is able by means of the memory trace to learn from his errors.
    - Errorless learning eliminates the chance of making errors during training and that produces a success experience and contributes to the patient's self-esteem and motivation.

  - The endeavor is to achieve automation of skills by striving for perfect execution of the steps: *overlearning*. It is only when a step has been mastered perfectly that there is progression to the next. Training all these steps to become a fluent skill is called *chunking*.
2. *Chaining:*
   - Forward chaining means having the patient carry out step 1 and helping the patient to carry out the other steps. This is repeated until step 2 is mastered and this is repeated for the subsequent steps.
   - Backward chaining means that the patient does the last step himself. In other words, he finishes the skill himself and thus the success experience is emphasized. Then the last two steps are carried out and so on.
   - This is a way to slowly learn certain skills.

Strategy Training

The purpose of strategy training is to learn to compensate for impairments and is not aimed at recovering function. The loss of cognitive functions is accepted, and a search is made for strategies that are aimed at working around the impairments that lead to failure. The results are better when the patient has good awareness of illness and insight into his own cognitive limitations.

Example from Practice 7.8

Mrs. P. has early-stage dementia that is characterized by problems in her short-term memory. These processes take place in the hippocampus, which is involved in storing new memories that are related to facts or events. This is also known as the declarative or explicit memory. Informative knowledge that is interesting or important for someone is stored in the cortex (long-term memory). This process is called consolidation. When there are problems with short-term memory, the events or appointments that you make are not registered in the cortex. Because of this, it is impossible to recall them later.

Mrs. P. finds herself often faced with this and regards that as very annoying. She has taught herself a strategy. She writes down the important things immediately in a diary. This can vary from things she has experienced to appointments that she has planned. It does however require discipline, but by applying this strategy consistently, it has become something she does automatically. Because of this she is able to tell her husband all about what has happened during the day.

Examples of effective interventions (Heugten 2006) are:

1. Diary training for memory problems.
2. Scanning and visualization techniques (NHS 2001) for neglect (◘ Box 7.4).
3. Self-instruction according to Meichenbaum for reduced persistent attention is a strategy that leads to reduced distractibility. By having the patient verbally guide himself through a task, the attention to the task improves. This can bring about a more effective execution of the skill.
4. Strategy training for apraxia (Heugten 2006).
5. *Time pressure management* is a strategy which belongs to the repertoire of cognitive rehabilitation and is used in the case of attention problems and slowed information processing.

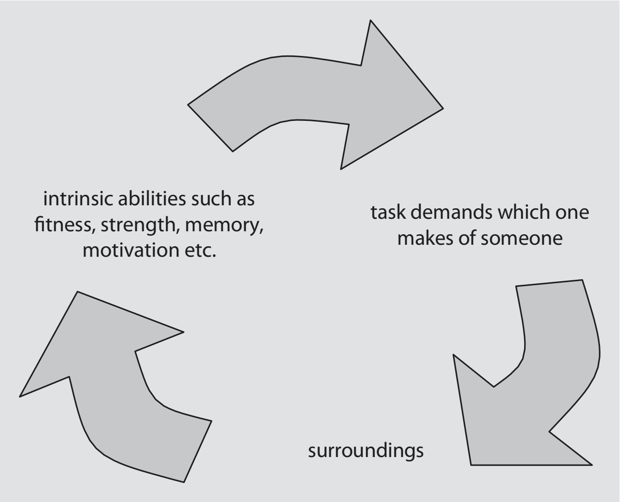

Fig. 7.8 Adaptation of task and surroundings

Behavior Modification

Behavior modification is aimed at reducing undesirable behavior by ignoring it and allowing desirable behavior to increase, by means of positive reinforcement. This is called operant conditioning.

Adaptation of Tasks and Surroundings

When there is nothing more to be gained in the intrinsic abilities of the patient, external factors that could have an influence on functioning need to be examined. The tasks and surroundings of the patient can be starting points for intervention. An assessment is made of whether influencing one of these two factors, or both could lead to the patient functioning better in his surroundings.

Account needs to be taken (in terms of the *task demands* that are made of the patient with cognitive problems) of resting, surroundings that are peaceful, doing one thing at a time, and adapting the pace (see Fig. 7.8).

In terms of the *surroundings*, the following aspects need to be considered, which are known to benefit people with cognitive problems:

1. A low stimulation: tranquil environment that is low noise (such as people walking in, background music, telephones, etc.)
2. Structure: including being cared for by the same person and fixed therapy times
3. Predictability: the same rituals each day (e.g., eating, then washing up, and then resting)

With regard to adaptation of tasks and surroundings, there is much to be gain by dealing with this consciously and creatively. Moreover, a large capacity for empathy is also necessary.

Example from Practice 7.9

Mr. R. has dementia and has an impaired orientation in time, place, and person. We try by means of structural external stimuli to provide him with information about the here and now.

Disorientation in time

You can respond to this in various ways. To start with you can, every day, put the date and the year on a whiteboard. You can name the current season, for example. You could give him a watch that peeps every half hour and thus draws his attention to the time. Together with him, you talk to him through the facts of his life by, for example, starting with getting married, having children, working history, and then talking about the present day.

Disorientation in place

The surroundings must be arranged as such that the limitation that Mr. R. experiences is reduced. You could think in this context about using colors, signposting, and pictograms to indicate the function of the room and make sure there is good lighting. It is possible that Mr. R., in the long run, will know the way himself to the various rooms. This one calls mental practice. This means that through repeated practice at the unconscious level, processes take place resulting in the route being stored. One downside is then to assume that he can find his way around in a different department.

Disorientation in person

In this case you need to think of using name tags, having the names said repeatedly, inventing games during group activities where the name must be said, etc.

Box 7.4 Cognitive Function Training

In some cases, cognitive function training is, however, effective. In the Sint Maartenskliniek in Nijmegen, a scanning training is offered to people with a *neglect* (e.g., reduced attention to a part of the visual field). The patient is seated in front of a large screen measuring 3 × 2 m. On this screen, there are 48 positions, 4 vertical and 12 horizontal. A number is projected somewhere on the screen, and the patient has to press a button as fast as possible when he sees it. This way the response speed is measured. The training structure is from right to left, and in the course of the training, the stimuli become less and less predictable.

The training takes place over a 6-week period and lasts 1 h per working day, a total of 30 h. The results show that visual scanning training reduces the neglect and demonstrate generalization to the ADL.

Box 7.5 Strategy Training for Apraxia

When apraxia is present, it is appropriate to match the learning strategy (► Chap. 9) to observations. As, for example, apraxia is observed during dressing, is it important to discover whether this is based on:

- Visuospatial problems: in that case, it is possible to use backward chaining (see for this «Skills Training»).
- A reduced specific attention: in that case, the choice could be to allow the patient to verbalize what he has to do. The task focus is then greater.

Matching the learning strategy to observations is the most effective method for apraxia. You do not treat the apraxia, but you do train the skill.

Box 7.6 Time Pressure Management

Time pressure management is a strategy where time pressure is avoided as much as possible. This has an added value for patients with a CNS disorder, because they frequently experience mental inertia. Taking decisions quickly and also acting in response to the situation is often difficult for them.

By looking at what kind of decisions have to be taken while driving or cycling, it will be clear at what levels decisions can be taken.

- Imagine, the person driving in front of you brakes suddenly. You have to react quickly to that; so that is therefore a decision with high time pressure.
- You are driving along and it suddenly starts raining. You put on your windscreen wipers and gradually slow down. This is a decision with less time pressure.
- You need to cycle to some place. In advance, you think about how you are going to cycle there in order to, for instance, avoid busy crossroads. This is a decision without time pressure.

For people with slowed information processing, adaptations in terms of tactics and strategy are very important. Through this favorable conditions come about in order to be able to act adequately according to the situation. For most people, it is normal to chat with each other while cycling in traffic. For someone with a CNS disorder, it is better not to do this and keep looking forward. In this way he creates time to react if something unexpected happens. It is also advisable for him to always keep his distance (tactical), so that there is more time for anticipation.

Time pressure management is a strategy that is easily deployed and proves to be effective for CNS disorders.

Box 7.7 Diary Training

Diary training when there are memory problems has proven to be an effective strategy, which can be learned in a group. The inclusion criteria for the participants are the following:

1. The participant can read.
2. The participant is oriented in time, place, and person.
3. The participant must able to focus his attention and to keep focused to some extent.
4. The participant must be in some degree of awareness of illness.
5. There must be some degree of ability to learn.

The aim of the diary training is to get participants to regularly check their diary to see what activities are on their schedule. Another aim is that they are able to give a concise summary of what has been done, discussed, or agreed.

Application in a rehabilitation center:

In practice we saw that the participants appreciated the added value of using a diary, but that they were not consistent in their use of it. We then linked diary use to a reward system. If they could show that the diary had been adequately used each day of the week, they were given a token. Those who were able to hand in three tokens were allowed to go to the market on Friday to buy the ingredients for their favorite meal. This was then prepared with the activity leaders. After introducing this reward scheme, the diaries were used better.

7.6 Chronic Fatigue, Depression and Burden, and Resilience

Chronic fatigue and depression have a correlation with each other that works in both directions: depression is more often manifested in people who experience chronic fatigue, and people who are depressed more often suffer from chronic fatigue than people who do not suffer from depression. The treatment intervention for chronic fatigue is discussed further in ► Chap. 8.

7.7 An Impairment in One or More Feedback Systems

A characteristic with a CNS disorder is the presence of an impairment in one or more feedback systems. These feedback systems concern:

- Sensation
- Auditive perception
- Smell
- Taste
- Vision
- Cognition

As a physiotherapist, you spend a lot of time with the patients practicing motor skills. When learning motor skills, motivation and feedback are essential for turning learning into a success. The chance of an impairment in one or more feedback systems is very high in the patient with a CNS disorder. This must therefore be investigated in order to be able to determine the right learning strategy. Which *feedback system* you address within the chosen learning strategy is very important. This is discussed in detail in ► Chap. 10.

■ Final Note

Fatigue has not been discussed in this chapter as an influenceable function. However, the next chapter is entirely dedicated to this topic because fatigue occurs very frequently in CNS disorders (Horstenbach and Mulder 1997); it is therefore experienced by people with a CNS disorder as very limiting beside the major impact it has on other functions.

Fatigue in CNS Disorders

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Summary

Fatigue is a frequently occurring symptom in CNS disorders. It has also been shown to be a major limiting factor in general functioning and to have a negative influence on any neuropsychological function impairments that may be present. Fatigue is easy to treat from the biopsychosocial perspective. Providing insight into burden and resilience and offering the patient tools for rediscovering the balance are all part of physiotherapy care. From the same holistic vision, it is also possible to influence the limbic system in such a way that the subjective perception of fatigue is reduced. The goal is to reduce the influence of the stressors (negative emotion, negative cognition, and negative coping behavior) as much as possible in such a way that desensitization of the limbic system occurs. Positive reformulation and redefining of negative ideas contribute to the reduction of experienced fatigue. Coaching and helping the patient to learn positive coping behavior can contribute to achieve structural changes. Desensitization of the limbic system also leads to less sensitization of the paralimbic regions of the brain, resulting to a positive influence on the functions that are regulated from those areas, such as memory, sleep, and mood.

8.1 Introduction

Fatigue is a frequently occurring symptom in CNS disorders. It has also been shown to be a major limiting factor in general functioning and to have a negative influence on any neuropsychological function impairments that may exist. For this reason, it is worth taking a closer look at fatigue and knowing which options exist for influencing this symptom.

This chapter firstly states what fatigue is and looks at the hypothetical causes of it. Then, two options are proposed from the biopsychosocial perspective that could be implemented in the physiotherapy care of the patient with a CNS disorder. Fatigue is easy to treat from the biopsychosocial perspective. Providing insight into burden and resilience and offering the patient tools for rediscovering the balance are all part of physiotherapy care. From the same holistic vision, it is also possible to influence the limbic system in such a way that the subjective perception of fatigue is reduced. The aim is to reduce the influence of the stressors (negative emotion, negative cognition, and negative coping behavior) as much as possible, which then results in desensitization of the limbic system occurring. Positive reformulation and redefinition of negative ideas contribute to the reduction of the fatigue experienced.

Coaching and helping the patient to learn positive coping behavior can contribute to achieving structural changes. Desensitization of the limbic system also leads to less sensitization of the paralimbic regions of the brain, resulting to a positive influence on the functions that are regulated from those areas, such as memory, sleep, and mood.

It is known that fatigue occurs very frequently in CNS disorders. Given the impact of this symptom on the entire functioning and the other existing impairments, treatment of fatigue will contribute to better general well-being. Because of this, the patient will function better in his immediate surroundings. This chapter does not claim to be complete, but aims to make influencing fatigue a structural component of physiotherapy care (◘ Figs. 8.1, 8.2, 8.3, and 8.4).

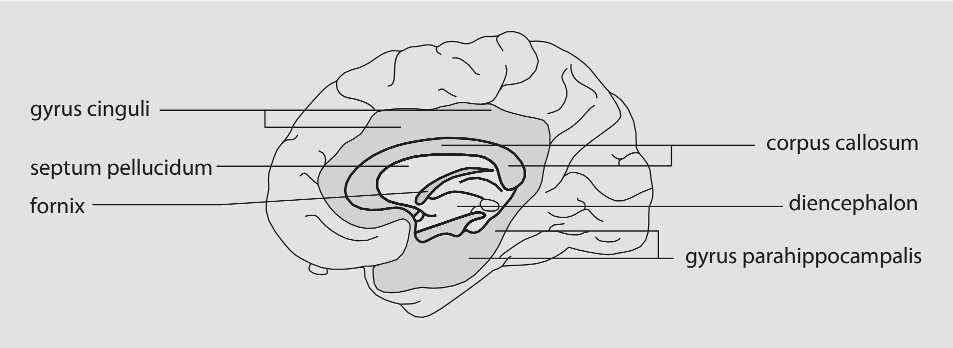

Fig. 8.1 The limbic system and its connections

Fig. 8.2 Graded activity A

Fig. 8.3 Graded activity B

8.2 Fatigue

Fatigue is a major problem for people with a CNS disorder. Firstly, it is not pleasant for them to feel constantly tired. Secondly, it creates problems through the impact that fatigue has on the other impairments that exist as a result of the CNS disorder.

The chronic fatigue experienced by people with a CNS disorder means their ability to adapt is small. This can lead to the cascade breakdown phenomenon; this means that a relatively small disruption can upset the fragile balance resulting in a speedy decline.

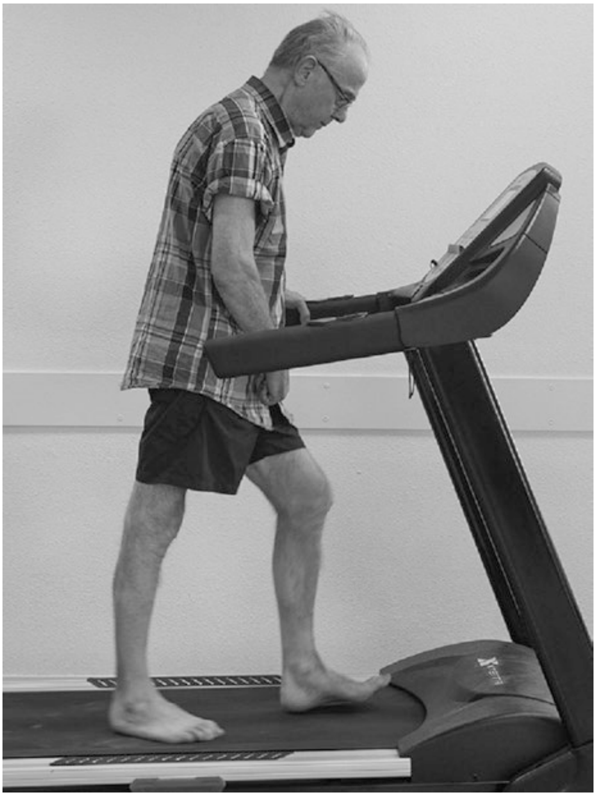

Fig. 8.4 Graded activity C

Example from Practice 8.1

Mrs. J. has Parkinson's disease and is classified as stage 3 according to the Hoehn and Yahr classification. She lives in a service flat and is independent in her ADL. She has a slight cold. Because of her kyphotic posture, she has less power to cough. After 2 weeks, she is still being bothered by the same cold.

In the end it turns into an upper respiratory infection because of her inability to cough up sputum. It costs her a lot of energy. She thus now also needs daily help, because she is no longer able to run her household. She needs to rest a lot more, and this leads to a reduction in her stamina. Eventually the home care has become an essential part of her daily functioning as a consequence of this slight cold. She is now classified as stage 4.

The literature does not reveal any unequivocal definitions of the term «fatigue.» The definitions of *normal* and *pathological* fatigue are:

1. Normal fatigue: state of general tiredness that occurs after effort and that improves with rest
2. Pathological fatigue: a state that is characterized by fatigue that is not been related to preceding effort and that does not recover with rest

Research has shown that fatigue occurs a lot with CNS disorders. In one study conducted 9 months after the CVA, both the partners (83%, n = 143) and the patients concerned (74%, n = 172) indicated that this symptom is present and forms a major limiting factor for general functioning. This also applies to the other CNS disorders.

8.3 Hypothetical Causes of Fatigue

We talk about hypothetical causes, because there are no perceptible abnormalities that can explain the occurrence of fatigue. They are also called *idiopathic symptoms*, but that does not mean that the complaints are not real. Thus, for example, it has been shown in terms of experiencing pain that someone who is rejected or left in the lurch actually feels pain (Eisenberger et al. 2003). It produces disruption in the limbic regions.

As a result of which, the adaptive interactions between the mental activity and the visceral situation become disrupted, and psychosomatic phenomena can arise. This is a confirmation that idiopathic symptoms, such as fatigue, can lead to subjectively experienced symptoms.

With specific events, it is good to remember that this can have an influence on the limbic system. The next example illustrates that.

Example from Practice 8.2

A woman was robbed of her handbag and indecently assaulted in Paris 6 years ago. She thought that she had dealt with it well in the meantime. She lives in Amsterdam and the same sort of things can happen there after all. In spite of that, she had no problems being alone on the street, also at night.

Until she went back to Paris again. It was the middle of the day. She walked through the alleyway where the attack had happened. She started walking faster, her heart was racing, she felt hot, and she was constantly looking around.

In the literature, the following are given as possible hypothetical causes of fatigue:

- Physical changes, such a change in nutritional status, biochemical abnormalities, systemic diseases, and a reduced mobility.
- A combination of the CNS disorder and the psychosocial stress that is associated with this: learning to deal with the sudden health threat, the loss of functional abilities, and an intensive and long-term rehabilitation process.
- Sleep disorders, such as insomnia, hypersomnia (pathological sleepiness and an increased inclination to go to sleep), and apnea (temporary cessation in breathing during sleep).
- Diminished cognitive functioning, such as memory and concentration.
- Overdemanding (internally or externally) and, as a result, the feeling of always having to perform on the limit of the ability to function.
- Compensation of impairments: this takes a lot of energy.

Fatigue can also be an indirect consequence of other factors that are present, for example:

- Medication.
- Reduced energy level and an disrupted balance of burden versus resilience.
- A feeling of having not much grip on one's own situation (external locus of control).
- Gloominess/depression. From a previously mentioned study (Hochstenbach and Mulder 1997), it was apparent that depression is a frequent problem for CVA patients. Nine months after the CVA, both the partners (50%; $n = 143$) and the patients concerned indicated (45%; $n = 172$) that there are depressive moods. This is also known to be the case with the other CNS disorders.

The presence of depression in patients with CNS disorders can have an organic cause or be a response to the pathology. This is relevant for the treatment intervention. Organically defined depressive moods can easily be influenced, as it happens, by medication.

Fatigue and depression are closely related with each other, but can also occur independently of each other:

- Fatigue and the presence of depression: 39%
- Fatigue and the absence of depression: 38%

Through this close relation, treatment of the depression can contribute to reducing the fatigue experienced. The identification of depression in a patient with a CNS disorder should therefore be part of the multidisciplinary care plan during rehabilitation.

8.4 Biopsychosocial Model

Models are often used within the (para)medical world. The purpose of this is to make the complexities of the human body more transparent. The biopsychosocial model is one of those models.

In medical research, symptoms are often explained according to the *biomedical model*: that is to say that a disease or disorder is or can be explained medically. Example: an abnormality in the pancreas results in the blood sugar level becoming abnormal.

In addition to this biomedical model, the *psychosocial model* is also used: the disease or disorder is explained by a disruption in psychosocial functioning. Example: someone is too busy at work and is forced to work in the evenings. He can consequently not keep up with his social contacts, and after 3 weeks, he finds himself with headaches.

If these models are viewed independently of each other – psyche and somatic are separated – then these are called *dualistic models*. If the models are, by contrast, regarded as inextricably bound together, this is known as a *holistic model*. The person is thereby considered as a *biopsychosocial* entity. «Bio» stands for organic level (e.g., the pancreas), «psycho» for the person level, and «social» for the person and his surroundings, placed within the social and cultural context.

From this model, it is assumed that several factors are present that maintain the problems that have arisen.

Example from Practice 8.3

Mr. W. has a pancreatic disorder, and as a result, his blood sugar level is not regulated (biomedical). It is noteworthy that the deregulation of his blood sugar level always occurs out of the blue, despite his structured daily routine. This makes it all somewhat uncertain, because when he has a hypo he loses consciousness.

For a number of years, the frequency of the number of hypos has not been so high, and generally they occur at night. When this happens, his neighbor comes to his aid. In the last year, on the contrary, he has found himself having a hypo in the middle of the day. Mr W. has decided to no longer drive for that reason, and the result is that he is less able to get out and about (*social*). He is really fed up with this, and to add to his misery, things are not going well at work. He works for a large bank and there have been a succession of reorganizations. He is afraid that it will be his turn, at some time, to be made redundant.

On the one hand, he has been advised by his doctors to claim incapacity benefit, but on the other hand, he really likes working. However, if his turn comes to be made redundant, he will in the long term lose out financially. It has been on his mind a lot and he's not happy about it (*psyche*).

The hypos increase in frequency, to that one, where he falls into a coma (Source: *In memory of Roland* account from the author's own practice).

8.4.1 Influence of Fatigue in CNS Disorders

In the following, we discuss two approaches that can contribute to reducing the fatigue that is present. They have arisen from a biopsychosocial perspective of people and with that are very relevant, because when successful a positive influence can be *indirectly* observed on other impairments as a result of the CNS disorders (spasticity, depression, cognitive impairments, etc.).

Burden and Resilience

Health is defined as follows by the World Health Organization: «a state of complete physical, mental, and social well-being and not merely the absence of disease.»

In addition, it is important that a person has the capacity to sustain himself in an existing state and know how to adapt to changes. Health is a dynamic balance between burden and resilience:

- Burden is the entirety of factors that define what an individual has to do or wants to do in daily life.
- Resilience is the entirety of factors that define what an individual *can* do.

If we look at the influenceability of both, we can conclude that both burden and resilience can be influenced.

Burden

When it comes to a CNS disorder, it is easier to reduce the burden than to increase the resilience. The hypothetical causes of fatigue can be categorized with the burdening factors. The question then is whether they are influenceable. If the response is yes, the interventions must be matched to this. By showing the hypothetical causes schematically (see ◘ Table 8.1), it is possible to provide transparency into the treatment strategy. Moreover, it provides an overview of who is responsible for the strategy.

Resilience

Resilience can also be influenced, and by doing so, an indirect influence can be brought to bear on the burden experienced. Training stamina and strength or learning a positive coping behavior can contribute to that. In practice, it is apparent that there is frequently an imbalance between burden and resilience. With a CVA patient, it often goes as follows in the real world:

- Acute phase, week 1: in the acute phase, the shock of what has happened predominates. There is an admission to hospital and there is not as yet an imbalance between burden and resilience.
- Subacute phase, weeks 2 to 4: the spontaneous recovery and the accompanying possibilities are typical of the subacute phase. The patient is often highly motivated. The home front sees that progress has been made and hope for successful rehabilitation. In this phase, there is still no imbalance in burden and resilience.
- Post-acute phase, week 5 to month 6: the post-acute phase is characterized by stagnation in spontaneous recovery. This does not mean that the progress in functioning is also limited by this. The patient experiences this phase as very confrontational. He starts, namely, to realize that the sequelae that are still present are permanent. There may be a period of grieving, and during this phase of learning to deal with it, there can be an imbalance in burden and resilience.

▣ **Table 8.1** Overview of hypothetical causes of fatigue, influenceable factors, and who is responsible for the strategy

Hypothetical cause	Influenceable factor	Who is responsible for the strategy
Physical changes	Yes, including by means of information and explanation and rehabilitation	Dietician, physiotherapist
CNS disorder and the psychosocial stress	Yes, including by means of information and explanation and psychotherapies	Psychologist
Sleep impairments	Yes, including by means of medication or relaxation exercises	Doctor
Diminished cognitive functioning	Yes, including by means of learning good strategies	Occupational therapist
Overdemanding, internal or external	Yes, by means of information and explanations and recommendations for how to deal with this	Social worker
Compensation strategies	No, because these are necessary to be able to function at a higher level; does indeed cost energy, but also get results	
Medication	Yes, the danger of polypharmacy frequently lies in wait and this must constantly be critically reviewed	Doctor
Gloominess/depression	Yes, including by means of medication, physical effort, and psychotherapies	Various

Box 8.1 Grieving

Grieving is a risk factor for health. A significant loss upsets the body's immune system and upsets the hormonal balance. The chance of illness and physical complaints increases. Among other things, there is an increased risk of brain hemorrhages, heart attacks (*broken heart*), and disorders of the organs. For people with a fragile homeostasis and as a result with little ability to adapt, the loss of the partner, for example, can be the last straw.

With respect to rehabilitation, this means that an assessment has to be made between, on the one hand, the burden and, on the other hand, the benefits that rehabilitation could produce. Ways of supporting the fragile balance can be sought, both with respect to the loss of functions, but also coaching in finding new activities that provide diversion and are meaningful.

A well-motivated patient is, of course, a plus when it comes to treatment. With grieving it is about balance between, on the one hand, being occupied with dealing with the loss and, on the other side, offering diversion and finding new possibilities. As far as the last point is concerned, the physiotherapist can be of great use in seeking new possibilities.

Resilience can diminish and rehabilitation is then viewed as a burden. That means giving in on both sides. People in the patient's direct surroundings will start realizing that the sequelae are there to stay and that a lot will need to be arranged. For the family and friends, the burden will increase. This phase is very relevant. Showing empathy to both the patient and the family and friends can be experienced as very valuable. Good information and explanation are important at this stage.

- Chronic phase, after 6 months: if the patient has achieved a level that he allows him to go home, that is of course a reason for joy. He looks forward to that and initially it will all go very well. As time goes on, the patient will, however, experience what the sequelae of the CVA signify for functioning in the ADL. If this is disappointing, it often is accompanied by feelings of depression and that has an influence on the balance in burden and resilience.

Box 8.2 Together Further

It is a known fact that a patient following discharge from a rehabilitation center falls into a bit of a hole. The initial period at home is of course great, but after a while, the patient and his family discover what the sequelae mean in daily life.

For many years, I worked for the patient association «Together Further,» and I heard these sad stories. Disappointments, having little to do, fatigue, irritability, and depressive feelings were frequently discussed items. They did not contribute to the resilience of the patient or that of the partner, but they have to carry on together further. The resilience of the system steadily became smaller.

These stories and experiences led to self-reflection within the institution where I work, from which the conclusion was drawn that the aftercare offered after a period of intensive rehabilitation was minimal. More time and money has now been invested in this in the last two or 3 years. Information meetings and exchanging experiences under the guidance of a moderator have now, in the meantime, come to occupy a structural place within the care plan after patients with a CVA are discharged (Source: work experience of the author).

In ◘ Box 8.2, a sketch is provided of what frequently happens with a CVA patient. This provides insights into what one must be alert to in the various phases. Consciously considering burden versus resilience contributes to that.

The clinical picture of a CVA is stable, and for this reason, homeostasis will arise in the burden and resilience in the long term. This is in contrast to disorders such as MS, Parkinson's disease, and dementia, which are characterized by their progression and the accompanying loss of functions and functioning. With these CNS disorders the fact is that balance must be more frequently sought. Stimulating the patient to learn positive coping behavior can contribute to this balance being found more rapidly.

8.4.2 Central Neurological Approach to Fatigue

From the biopsychosocial perspective, a central neurological explanation can be found for the chronic fatigue that is experienced, namely, the limbic explanation.

Neuroscientific research shows that the psyche and the central neurological functions are interrelated. The psyche has organic roots in the brain and is, just like language, a brain function. According to the sensitization hypothesis of Ursin and Eriksen (2004), stressors bring about cognitive activation, particularly in the limbic system. It is known that the somatic factor interleukine-1, for example, causes postoperative fatigue and depressive feelings and these could be active in these areas as a result of persistent stressors. Because of this, sensitization of the limbic system occurs, which may be an explanation for the occurrence of fatigue (Ursin and Eriksen 2004).

This has been further developed in a stressor sensitization model, and an explanation is provided on the basis of that model for the occurrence of chronic «idiopathic» physical symptoms, including depression and fatigue. To understand this, insight into the function of the limbic system and into the connections from this system to other areas of the brain is necessary.

▪ Anatomy of the Limbic System

The limbic system is, from the evolutionary perspective, the oldest part of the human brain. One of the functions of the limbic system is to receive information from the body (muscles, viscera) and from the brain (cognitions, perceptions). Behavior and emotion are determined on that basis.

The limbic system learns from experiences. As a baby, you cry when you are hungry, and as a toddler, you cry when you fall on your knee. As a child, you are angry when you are only allowed four sandwiches, and as a teenager, you are irritated when your parents show interest in your love life. On the other hand, as an adult you can postpone your hunger feelings, you curse when you fall on your knee, you do not want to eat four sandwiches because you get too fat, and when someone shows an interest in your love life, you experience it as being interested. The limbic system learns by doing, and it regulates your emotional responses to events.

The limbic system lies between the brain stem (vital functions) and the cerebral cortex (complex functions). The system lies like a ring around the ventricles of the brain. There is also a paralimbic circuit in a narrower sense. This means that there are common connections between the limbic system with regions that include the hippocampus, the hypothalamus, and a part of the thalamus.

The limbic system is therefore not a single separate part of the brain, but is continuously in contact with the other regions of the brain. Because of this, the various regions have an influence on each other:

1. Hypothalamus: From this region, neuroendocrine functions are controlled such as temperature, water balance, and sleep rhythm.
2. Thalamus: Nociceptive stimuli pass through the spinothalamic tract and are connected to the limbic system. If this is ongoing, then sensitization can occur in the limbic system. When there is such chronicity, we speak of experiencing pain. Chronic pain and the experiencing of it are therefore influenceable via the limbic system.
3. Hippocampus: This is where mainly memory processes take place. When these processes are coupled to emotions, they have a greater impact. It is known that in dementia patients, emotional events are better retained and stored.

▪ Fatigue from Within the Limbic Perspective

In ► Sect. 8.1, normal fatigue and pathological fatigue were defined. From the limbic perspective, fatigue is defined as follows: the fatigue syndrome is not a figment of the imagination, and it does not disappear automatically. It is a real complaint that is defined by many factors and that also must be approached as such. The treatment concentrates on the consequences.

Cultural factors play an important role in the multifactorial complaint. This concerns the expectations, conceptions, and ideas of the patient. What sort of idea does he himself have about the fatigue and the prognosis and how does he think that can be positively influenced?

Example from Practice 8.4

Mr. C. had a CVA 6 months ago. Because it has been shown that training stamina leads to an improvement of the cardiorespiratory system, improves the aerobic capacity, and lowers blood pressure, I suggest to him that this should be trained.

Mr. C. has a completely different idea about this, because the neurologist has told him to take things easy. After asking him some more questions, Mr. C. admits that he thinks that by exercising his blood pressure will rise and that will increase the chance of another CVA. A real fear it is if the blood pressure were indeed to rise.

Because it has been shown that fitness training actually leads to an improvement in blood pressure, an appointment is made with the doctor to discuss this. Subsequently, the blood pressure is measured a number of times before and after the fitness training; it remains stable. This is once again an affirmation for Mr. C. His fear of exercising has been removed, and at the end of the 8-week fitness training program, he states that he's feeling happier. His activity level at home has also improved.

An equally important role in influencing fatigue is played by the family and close friends and their reactions. The patient is confronted with them on a daily basis. The family and close friends regularly use terms such as mental, lack of attention, secondary illness profiting, imagined problems, and «it's in the mind.» This is not a serious approach to a real complaint.

Example from Practice 8.5

Mr. S. had a tumor in the brain that was removed 2 years ago. He functions at a good level in terms of motor skills, and cognitively and in fact, you cannot tell by looking at him that he has any problems. For his family and friends, a number of things are apparent. If he is tired, he starts stammering and has more difficulty with speaking.

Fatigue is a major problem, and for this reason, he has adjusted his working hours so that in the evenings, he is to maintain his social contacts to some extent.

He is a production worker in a big factory, and his colleagues actually think it is all nonsense. «You can see anything when you look at him,» and «I'm tired too sometimes» are recurring bullying digs. Mr. S. tries each time to explain that his fatigue is different, but does not find a sympathetic ear. He does not feel that his colleagues take him seriously and he is not happy about that.

These cultural factors are regarded as stressors of the limbic system that maintain symptoms. Because of this, sensitization occurs, and the limbic system is in a constantly increased state of arousal. It is very important to reduce the influence of the stressors and to focus the treatment strategy on this.

■ Stressors of the Limbic System

Negative emotion

Negative emotion can be consciously or unconsciously present. If that emotion is consciously present, the patient speaks about with ease. If that is not the case, he adopts a defensive or denying attitude. Negative emotions can be disavowal, grief, anger («why do I have a CNS disorder»), denial, the feeling of no longer the feeling belonging, etc.

Negative cognition

Incorrect ideas and irrational thoughts can have negative associations, and these can become negative cognitions. It happens, for example, regularly that someone with MS thinks that exertion is the cause of a relapse. Because of this, he may be hindered in undertaking activities, and that again produces negative emotion. The idea «exertion and relapse» has to be replaced by «activity and relaxation and therefore less stress.» That is less threatening and is positively formulated. This is called the conversion and redefinition of convictions.

Negative coping behavior

A persisting attitude that leads each time to a disappointment is called negative coping. This results in negative emotions. Examples of this are wanting to do more than you actually can, continuing to look for external assistance, pretending to be better than you are, dependent behavior, etc. It is possible that these stressors can be influenced by cognitive behavioral therapy, both internally (patient) and externally (surroundings). This treatment has proved effective for idiopathic symptoms (Wiefferink et al. 2001; Wessely et al. 1999; Li and Neugebauer 2004; Zambreanu et al. 2005). In this approach, communication is a prime factor, which defines whether the limbic approach strategy will be successful (see ► Sect. 10.2.2).

It is not always possible to get the patient to have insight through cognitions. For this reason, attention has to be paid to psychosomatic problems within physiotherapy care. The physical awareness of stress signals is often poorly developed in people who are socio-cognitively focused. This can be worked on using physiotherapy. The treatment runs in two phases:

Phase 1:

- Exclude an organic explanation, such as a chest infection, a virus, etc.
- Discuss that fatigue can develop; given the percentages in CNS disorder, it is worth considering seriously whether this should be implemented within a protocol.
- Information and explanation relating to behavioral characteristics that can sustain fatigue.
- Look for behavioral determinants and stressors that have a negative influence on the fatigue experienced.
- Coach healthy behavior by means of positive reinforcement of desired behavior and positive formulation of experiences gained.
- Convert and redefine inadequate convictions.

All these items form part of cognitive behavioral therapy.

- Graded physical exercise schedules
- Psychosomatic physiotherapy, where the emphasis lies on and is alert to stressors that have a negative influence on fatigue

Box 8.3 Cognitive Behavioral Therapy

Cognitive behavioral therapy is based on the concept that thoughts, feelings and behaviour are linked to each other in a certain manner. Negative thoughts such as «I am worthless» or «I can't do that» can cause or reinforce mental problems.

The cognitive behavioral therapist, together with the patient, will go through what ideas he has about himself and others, how people think about him, what he should actually do and/or can etc. Then the therapist will speak with the patient about the extent to which his ideas are based on reality.

The emphasis lies on learning other, more positive ideas. By influencing ideas the patient can change his mood in a favourable sense. As a result, his behaviour changes in positive sense and his symptoms reduce.

Phase 2 (after 6 months):

- Cognitive behavioral therapy
- Graded physical schedules
- Psychosomatic physiotherapy

Box 8.4 Graded Activity

A combination of cognitive behavioral therapy and graded physical exercise schedules are experienced as pleasant by patients in practice. Through positive reformulation of ideas and improving the coping behavior, a different perception of the symptom experience is brought about. The patient also notices that graded progression in performing physical work does not lead to an increase of fatigue. This motivates the patient and invites him to expand the activity level at home as well.

A graded schedule can look as follows:

- Set up a number of exercises together with the patient. Let someone, for example, cycle on a home trainer with the instruction: «Do your best, but don't force anything.»
- Next set up a program at 70% of the previous result. This means that if he can cycle for a maximum of 6 min at a resistance of 25 Watt, you take 4 min with a resistance of 25 Watt as the starting point.
- Build the schedule up gradually and have the patient keep everything noted in graphs you have made. You thus make his progress visible, because that has a motivating impact.

This is also called *graded activity.*

If these interventions produce no result, there is a possibility that it may be (given the time span) chronic fatigue syndrome (CFS). You have followed a specific path, and as such, the patient gets the recognition they need for this invisible symptom of a CNS disorder. Patients will then need to be given further care in dealing with the fatigue experienced in the best possible way.

Motor Control Models

F. van der Brugge, *Neurorehabilitation for Central Nervous System Disorders*,
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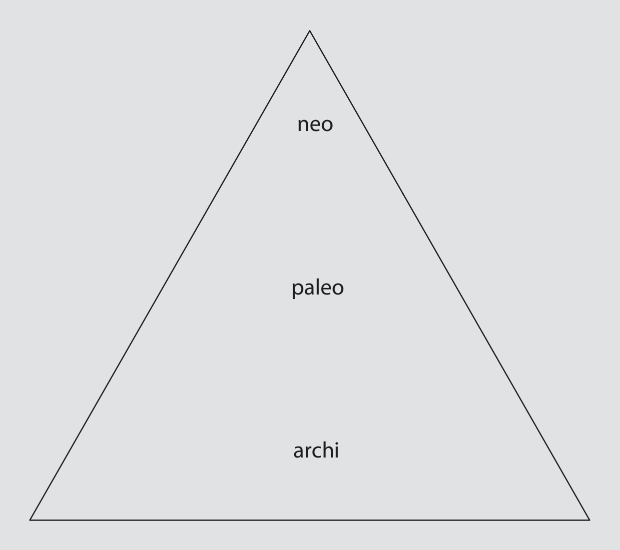
Summary
By looking at motor problems from several angles, it is possible to establish a treatment strategy with which you think you can achieve the best result. It is then a case of assessing whether that strategy also fits the patient and his immediate surroundings. If so, then every legitimate strategy that contributes to the independence of the patient is the optimal treatment strategy. Application of the models described in this chapter can contribute to formulating a multidisciplinary treatment strategy. The intention is not to describe them in detail. The aim is to make the models transparent by means of examples from practice. Thereafter, it is important to determine which learning strategy is the best match to the patient with a CNS disorder.

9.1 Introduction

Knowledge of the different motor models contributes to the ability to interpret the observed motor skills. They provide an explanation or hypothesis for why someone moves or acts in the manner that he shows. What follows is a description of a number of motor control models. It is not the intention to describe them in detail. The aim is to make the models transparent by means of examples from practice.

9.2 Hierarchical Model

Insight into the hierarchical model is relevant, because it has been a determining factor for a number of decades when it comes to deciding what should be included in treatment plans with respect to patients with a CNS disorder. The hierarchical model, on which the NDT concept was based, assumes that the higher parts of the brain control the lower parts. The consequence of a lesion in the higher functions is reduced control at the underlying levels. Primitive reflexes, according to this model, then gain the upper hand when there is damage in the cortex. When there is disruption at the paleo level (◘ Fig. 9.1), for example, problems can arise in the spontaneous motor system, as in Parkinson's disease.



◘ **Fig. 9.1** Hierarchical model

In this model, the occurrence of impaired self-righting reactions, primitive reflexes, and spasticity is explained from a hierarchical classification of the brain. The therapeutic interventions were matched in the last few decades to this presumed classification of the brain. Attempts were made to inhibit the muscle tone by means of manual interventions, and then efforts were made to regain normal motor skills. Empirical studies have since then made clear that the muscle-tone normalization achieved had no structural effects. Short-lasting muscle-tone normalization can however be the goal of an intervention, for example, when making a transfer or when the personal care of the patient is impeded by spasticity.

Example from Practice 9.1

Mr. P. has MS and experiences problems with getting out of bed because of the severe spasticity in both legs. He has been advised, before he makes the transfer, to move from lying on his back to lying on his side, to put his arms in the air first, and at the same time to move from left to right. This causes rotations in the trunk and by doing this the spasticity in the legs is inhibited. Once he is sitting on the edge of the bed, he has to put both feet firmly on the ground and slowly, by means of moving the weight repeatedly sideward and, then from the front to the back, put pressure on the feet. This facilitates the support function; as a result of this, it is easier for him to stand up.

This transfer gives him a lot of problems, especially if he has been sitting for a long time and if he has to make the transfer in a busy room.

Example from Practice 9.1 describes a hierarchical approach to a case. Previously it was assumed that structural changes would take place in respect of the spasticity. For this reason, the transfers were offered in this way, and there was not much freedom to deviate from that. In the meantime, it has been shown that there are no structural effects on the muscle-tone dysregulation through this approach.

Other approaches are, therefore, supplementary, because any manner of increasing the independence of the patient is welcomed. In the next example from practice, the same case is considered from a different motor model.

9.3 Heterarchical Model

The heterarchical explanation model assumes that the brain is an information-processing system that is in contact with its surroundings. Upper and lower parts work alongside and not in an upper/lower relationship. Within the context of this book, this means that spasticity is not only the consequence of the disappearance of the controlling function of the upper parts; it means that spasticity is also influenced by the information processing that has to take place. The degree of spasticity can be higher if someone is walking in a busy street, for example, and therefore all sorts of things around the person have to be perceived. In his trusted surroundings, this is not the case and the spasticity will be present but will be diminished.

Example from Practice 9.2

Mr. P. (Example from Practice 9.1) has difficulty with the transfer of sitting to standing, especially if that has to take place when he has been sitting for a long time or in a busy room. This last is the starting point for the explanation with the heterarchical model.

The transfer is practiced firstly in a quiet space. All attention can be focused on the transfer without Mr. P. having the feeling that everyone is watching him. The transfer is offered at the cognitive level (▶ Chap. 10).

After practicing for 2 weeks, Mr. P. has the transfer fully under control, and we move to practicing in his room with other chairs (associative phase). Variations in height and with different floor surfaces are made. Then Mr. P. goes and practices the transfer at the daytime activity center. Because he has mastered the transfer, he experiences, in spite of the presence of others, far fewer problems with his spasticity than previously in busy rooms.

After 3 weeks the transfer from sitting to standing is problem-free, despite the fact that the degree of spasticity in both legs remains unchanged. Automation under all circumstances has taken place.

9.4 Model of Action

The model of action describes the steps that are necessary to move from an intention or an instigation, to eventually have an actual execution of the movement (Smits-Engelsman 1994). Motor skills can be considered from this detailed description as motor behavior of a person in interaction with his environment. The model has been developed from a heterarchical vision, namely, on the basis of information processing.

Within this model, the ongoing anticipation, *tuning*, and feedback are assumed which take place in the motor skills. Tuning means the optimal use of the parameters (strength, range of motion, coordination), with the purpose of making the movement as efficient and economical as possible. The steps that are described can serve as an aid to observing where it goes wrong in the ultimate production of motor skills. The following steps take place:

Action planning	Cognitive levels
Motor planning	
Motor programming	Motor level
Parametrization	
Motor initiation	
Peripheral nerve transmission	Effectuation level
Strength generation	
Feedback	Cognitive level

Example from Practice 9.3

Mr. G. has had an infarct in the cerebellum, and his movements are ataxic as a result of this.

He takes part in group treatments. The task is to throw the ball while seated to the person sitting next to him. Mr. G. throws the ball to the lady sitting next to him, but so hard that the ball shoots past the target. This is typical for a cerebellar disorder, because parameterization (or the adequate adaptation of muscle tone during movement) is a function of the cerebellum.

The task is once again to estimate the distance and throw the ball more gently than he thinks is necessary (visual and cognitive strategy). When he throws a second time, there is already an improvement and by the third it is on target. He can throw the ball in such a way to his neighbor that she can catch it. He can convert the feedback concerning his actions into correct parameterization.

The model in this case therefore provides us with insight into which factors influence on the final motor skills (parameterization and feedback).

Example from Practice 9.4

Mrs. T. has early dementia. Motorically she can do everything, but nevertheless something goes wrong frequently. For example, a while ago, she wanted to go outside on a beautiful, but cold winter's day (action planning). She stood up to go to the shed (motor planning), to get her bicycle. She took her bicycle and rode out the garden. She felt that it was cold and went back to get her coat (motor programming). Getting her coat on was not easy, but she did not know why (feedback). She had first put on her mitts and was then trying to fasten the buttons on her coat (motor programming). She could not manage to do it. Fortunately, her husband was at home and he pointed out to her that fastening buttons with mitts on was virtually impossible.

The bike ride was lovely and after half an hour she arrived back home and felt a bit better. Her husband confirmed this. It seems that she functions better after physical exercise.

In this example from practice, the model shows us that there are problems in the motor programming and in the feedback about her own actions; there is in fact no feedback about her own actions. This is in contrast to Mr. G. in an Example from Practice 9.3. When you get no information about your own actions, you need to learn a strategy that results in you getting that feedback.

If we look at the intrinsic abilities of Mrs. T., we could choose to let her verbalize the skill step by step. Should this prove to be too hard, it is possible to look at what external aids could be used. For instance, photographs could be used in which the skill is shown step by step. Another possibility is the use of a voice recorder that guides the skill step by step. This choice depends on the question of which system (visual, auditive, etc.) is the best developed in her.

9.5 Task and Surroundings Model

The task and surroundings model has been described previously. When there is nothing more to be gained in the intrinsic abilities of the patient, external factors that could have an influence on functioning need to be examined. Task and surroundings of the patient

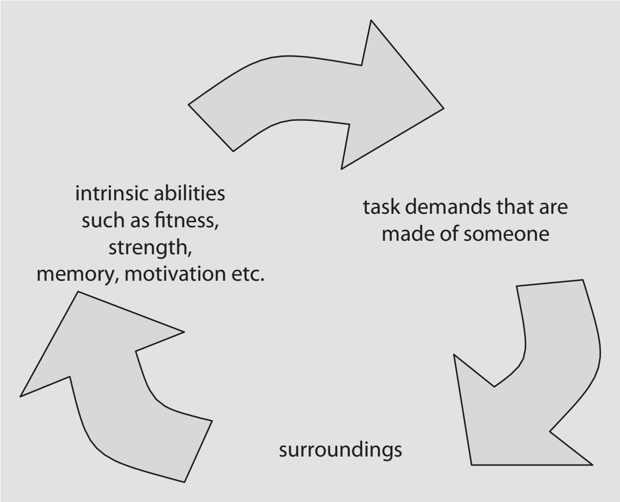


Fig. 9.2 Task and surroundings model

can be starting points for intervention. An assessment is made of whether influencing one of these two factors or both could lead to the patient functioning better in his surroundings (Fig. 9.2).

Influencing task and surroundings can be done from various perspectives. Example from Practice 9.5 makes that clear.

Example from Practice 9.5

Mrs. P. has had difficulty recently getting going and walking is no longer going as well as previously . Sometimes it seems as if her feet are stuck to the ground. Her hand shakes, but when she wants to pick up something, the shaking disappears.

Her family doctor tells her, after examining her extensively, that she has early Parkinson's disease and explains to her that it is a progressive disease. He adds that the clinical picture can remain at the same level for many years in spite of the progressive nature.

Mrs. P.'s world and that of her immediate family and friends collapsed. After a couple of weeks, she picks herself up and finds that everyone has been very thoughtful and caring about her.

In fact she has enjoyed it, all of the attention and thoughtfulness. Her partner did much more in the household. That was nice for her, because in recent years she has had to do everything herself.

After a while the attention dwindles away a bit. Everyone has got used to the idea and is back to doing their own thing. Mrs P. feels that is a pity and tries to reverse the situation. After all, she has still Parkinson's… She manages to do that and after a year or so the attention, the thoughtfulness of others and the jobs that were done for her, are now taken for granted by everyone. Because of this Mrs P. does not have so much to do and the idea occurs unconsciously to her and her immediate surroundings that it is good to take things easy. The Parkinson's is actually not getting worse.

A year later she gets worse and finishes up at the physiotherapist. He tries all sorts of things to motivate her to start being more active. He tries to get her to realise that activities at home, such as vacuuming and doing the shopping contribute to her well-being. But whatever he tries, he does not succeed in getting her to be active.

9.6 Biopsychosocial Model

The biopsychosocial model was described in ► Sect. 8.4. In this model, the link is made to fatigue, a symptom that is reported by many patients with a CNS disorder as being the symptom that they find the most limiting to their general functioning. Possible interventions are discussed in ► Chap. 8 that can be deployed to get a grip on the fatigue experienced.

Functional Exercise and Motor Learning

F. van der Brugge, *Neurorehabilitation for Central Nervous System Disorders*,
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Summary

Motor learning is the acquisition of a motor skill (Nijhuis-van der Sanden 2006) in a manner that is characteristic of the individual. In practice physiotherapists often have their own style of working and use that to teach the patient skills. However, it is more effective to adapt the method of working to the motor learning behavior of the patient. Consciously harmonizing with the specific learning style of the patient and his specific symptomatology results in more learning efficiency. In patients with CNS disorders, there are frequently information-processing problems with respect to, for example, auditive stimuli, perception problems, and sensation impairments. By testing, it is possible to discover which feedback system is still intact. Within the learning strategy, making use of the intact feedback systems, by way of compensation for the impaired feedback system, contributes to the effectiveness in relation to (re)learning a motor skill.

10.1 Introduction

Motor learning is the acquisition of a motor skill (Nijhuis-van der Sanden 2006) in a manner that is characteristic of the individual. In practice physiotherapists often have their own style of working and use that to teach the patient skills. However, it is more effective to adapt the method of working to the motor learning behavior of the patient. Consciously harmonizing with the specific learning style of the patient and his specific symptomatology results in greater learning efficiency.

In patients with CNS disorders, there are frequently information-processing problems with respect to, for example, auditive stimuli, perception problems, and sensation impairments. By testing, it is possible to discover which feedback system is still intact. Within the learning strategy, making use of the intact feedback systems, by way of compensation for the impaired feedback system, contributes to the effectiveness in relation to (re)learning a motor skill.

In doing so, you realize, however, that the impaired feedback system resulting from the CNS disorder has a residual capacity that can be used. Of course motivational and communicative aspects play a relevant role within motor learning as well.

In recent years there has been a tendency to practice functionally. As a result training functions has been pushed more and more to the background. In ► Chap. 7 it becomes clear, among other things, that training functions when treating patients with CNS disorders is worth considering, especially in the context of the studies that have been done into this and the positive effects of this.

■ Functional Exercise and Practicing Functions

Functional training is the training of components from the intrinsic system (see ◘ Fig. 10.1), in other words, everything that is within the human system, such as muscle strength, the cardiorespiratory system, attention, etc. Motor skills are also further

◘ Fig. 10.1 Motivation model

$$\text{motivation} = \frac{\begin{matrix}\text{perception of} \\ \text{chance of success}\end{matrix} \times \begin{matrix}\text{the value of} \\ \text{the success}\end{matrix}}{\text{the costs of achieving the success}}$$

determined by task and surroundings. If you want to do functional exercise, then task and surroundings should be involved. For example, walking on a treadmill is functional training, and walking in different surroundings targeting orientation is functional exercise. With the functional exercise of skills, insight in motor learning processes is essential. After all, it is about teaching someone a motor skill. We then talk of motor learning.

10.2 Motor Learning

Motor learning is the acquisition of a motor skill in a manner that is characteristic for the individual (Nijhuis-van der Sanden 2006). We use the term characteristic manner, because the learning strategy that someone uses is individually defined. One person learns to ski by making an analysis of the ski skills in a step-by-step manner before he ventures onto the piste. Someone else learns it by putting on a pair of skis and just heading down the hill. With the first way of learning, we can use the term *explicit* learning, also called *knowledge of performance* (KP).

In the second case, we can use the term *implicit* learning or gaining movement experience by means of *trial and error*. We can then use the term *knowledge of results* (KR).

Box 10.1 Implicit and Explicit Learning

Implicit learning takes place on a daily basis. It is a question of acquiring movement experience and learning from the feedback that you get. In childhood we learned how to do transfers and how to walk, but no one has ever explained to us how it works. It was a question of twisting and turning and falling down and standing up or *trial and error*. This is a typical example of implicit learning.

This therefore happens every day, until the moment comes that we have to learn something that in our perception seems difficult or dangerous. We then analyze it and we would like someone to do it first perhaps.

For example, take abseiling. If you have never done it, you do not think: I will just get on and do it and see what happens. You want to do it step by step, you define the route, and you have someone explain to you what is handy to do. We call this explicit learning.

In practice, physiotherapists each have their own style of working. They teach the patient skills and the choice of the learning strategy depends on the therapist's method of working. However, it is more effective to teach the patient skills in a manner that is appropriate to him. This means that the physiotherapist must discover what is the patient's learning strategy. If the therapist wants to put this into practice, then he has to have insights into various strategies of motor learning and be familiar with the processes that are responsible for attaining an effective learning efficiency.

Within motor learning three components are very important:

- Motivation
- Communication
- Feedback

10.2.1 Motivation Models

Motivation is a condition for attaining achievements. Patients with a CNS disorder will have to learn to control skills that no longer occur routinely. They must achieve something to master that skill. To achieve a particular learning efficiency, the patient will have to be motivated. If he is not motivated, the therapist will often have to take it upon himself to motivate the patient. That means that in his care for patients with a CNS disorder he will regularly run into the situation where he is the motivator in order to obtain an optimal achievement. Insight in Atkinson's motivation model shows which factors are determinative for the level of motivation. Insight into this offers the possibility of influencing the outcome of this (Geelen and Soons 1995) (■ Fig. 10.1).

Example from Practice 10.1

Mr. B. would like to run in a marathon. It is something what he has always wanted to do, and the challenge appeals to him enormously (intrinsic motivation).

He has already run a number of half marathons for which he did not have to do much training. His body is obviously built in such a way that he can actually run a half marathon untrained in a respectable time, namely, 1 h and 38 min.

«Running the marathon – that's a different matter –you have to really train for that,» according to Mr. B. (perception of the chance of success). You really have to run a lot of kilometers (costs of achieving success), if you want to set a bit of a reasonable time for the marathon (extrinsic motivator).

He thinks that through training he can finish the marathon and can do it in a decent time. Or:

- Perception about the chance of success → high
- Value of the success achieved → high

So far there is a favorable climate to assume that he will run the marathon, but we have not yet listed the costs. As indicated, Mr. B. feels that he needs to train intensively (costs) because he wants to run the marathon in a decent time (extrinsic motivation). However, he is a father with three young children. During the week, he has a full-time job, and on Friday evenings, he plays in a band. At the weekend, he regards his social life as important and he often attends parties. He also naturally wants to spend time with his family. As a result the costs of doing training are very high. Or:

- Costs of achieving success → very high

Conclusion: in spite of the high score «above the line» (the chance of success and the value of that success), Mr. B. still has not run a marathon.

In Example from Practice 10.1, we see intrinsic and extrinsic motivation. Intrinsic motivation is something you get from within, but it can be influenced by extrinsic factors.

A link can therefore be made to another motivation model, namely, Maslow's Needs Pyramid (1943) (see ■ Fig. 10.2).

Maslow's needs pyramid is a hierarchically constructed pyramid where we can see that an overlap exists between intrinsic and extrinsic motivators. Thus «need for appreciation and recognition» is something that is within you, but it can be also influenced by external factors. Recognition by a person who is very important to you can perhaps motivate you more than you can do for yourself. It can therefore be important to investigate which people are able to motivate patients.

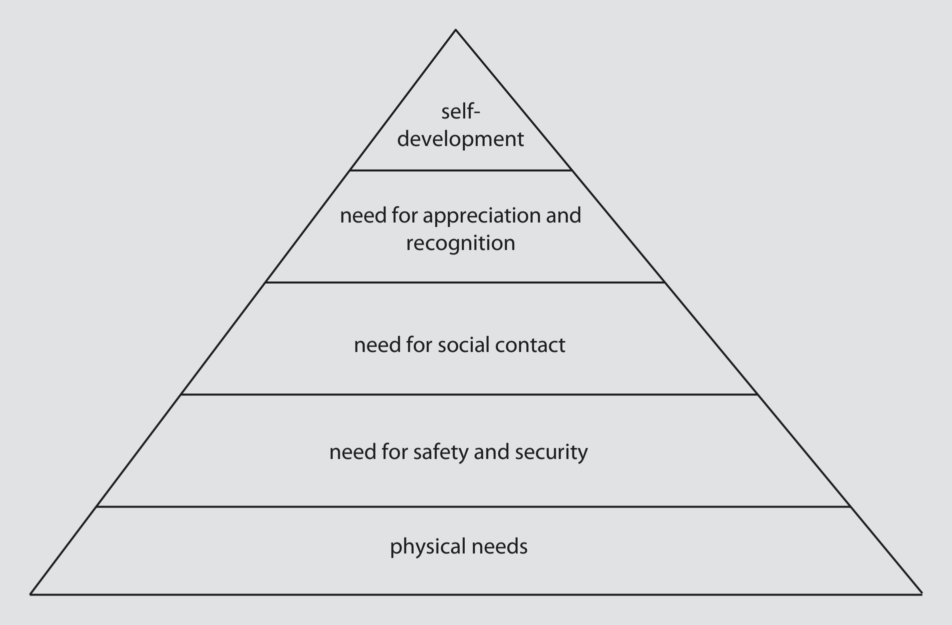

Fig. 10.2 Maslow's needs pyramid

Example from Practice 10.2

Mrs. J. has suffered a brain hemorrhage. Up to and including the post-acute phase, she had a hemiplegic arm and leg; afterward she began to make a good recovery. Scar tissue has been reabsorbed as a result of which the space occupied by the process has reduced and there is a return of functions.

Mrs. J. feels that she is making good progress and this motivates her enormously. Unfortunately less than 5 months after the first hemorrhage, she had a TIA. Fortunately she experienced barely any consequences of it, but it has scared her.

Two months later she has an infarction, a hemorrhage, a TIA, and then an infarction. She is very discouraged. Her motivation has decreased, because each time she has suffered setbacks.

Until the moment that her son comes to tell her that she is going to be a grandmother (for the first time). Because of this, she is highly motivated and she goes to the extreme. She says that she herself was not able to enjoy her own children to the full because of her busy work. Her son, who now becoming a father, had talked to her about that a couple of years previously and expressed his dissatisfaction. She wants to show them that she can be a good grandmother. Recognition by her zoon is very important for Mrs. J., and she wants to be able to enjoy her grandchild to the full.

Thinking about these models and trying consciously to focus on why someone is or is not motivated is important in terms of deploying the right motivation techniques. In this way it is possible to generate more learning efficiency from the physiotherapy treatment.

For both Atkinson's motivation model and Maslow's needs pyramid, communication is an important component which has a substantial influence on the level of motivation.

10.2.2 Communication

Communication can influence motivation in other people, both positively and negatively. Realizing the importance of communication is a key aspect within the physiotherapy care of patients. What is important in terms of the communicative interaction during physiotherapy care can be illustrated in a practical manner on the basis of the four social learning styles according to Kolb (Hendriksen 2005). The four social styles of Kolb form only one of the ways to examine communication. The purpose of this brief description is to indicate the relevance of communication in terms of physiotherapy care for patients.

▪ The Learning Styles According to Kolb

1. The doer. The doer is someone who seeks out new challenges and always has an abundance of ideas. He is a practical person and learns by doing. He is sensitive to recognition.
2. The reflector. The reflector is someone who often sees matters in a broader relation. He attaches a lot of value to harmony and is a real *team player*. He enjoys belonging somewhere and social contact is very important.
3. The decider. The decider is someone who is result-oriented and quick thinking. He takes decisions on the basis of knowledge acquired in practice. He attaches much value to clear, feasible goals. He is sensitive to being appreciated on the basis of results achieved.
4. The thinker. The thinker is someone who takes decisions on the basis of theoretical analyses. Procedures followed are important for him. He regards it as important to look over the details and attaches value to safety and security.

If you use this classification and want to apply it to match your communication, it is good to know that people have developed this style during their lifetime. It is the style with which they feel most comfortable and will not easily deviate from it. If you can recognize someone's learning style, you have the opportunity to match your communication to it. This can be an extra boost to influencing motivation positively (Ampect Consultants 2009).

Example from Practice 10.3 shows how the problem might be approached from different learning styles if Kolb's classification were to be used.

Example from Practice 10.3

Mr. P. has been told that he has MS. He knows that in the future motor problems can occur, and for this reason, he wants to train under the supervision of a physiotherapist.

We describe which information is important for a patient with one of the four learning styles according to Kolb:

- Doer. He does not have to know everything about MS but wants to get on with things in practice. By starting training now in advance, he will want to be able to show what he is capable of, in spite of MS.
- Reflector. He means what MS implies and is mostly worried about what it is going to mean for his wife and for his colleagues. For that reason he has started training now, so that he can continue to function well for as long as possible and thus support his wife and colleagues.

- Decider. He has found out a lot about MS and wants medication to reduce exacerbations. He wants to start training and to measure in 6 weeks' time whether he is benefitting from it. If not, then he wants to find out why not. Then he will seek out other means of reaching his goal.
- Thinker. He has investigated everything and wants to be offered a well-founded program. He wants to know whether enough breaks have been included in the training program because induced fatigued can have an influence on the occurrence of exacerbations.

In this example from practice, it is easy to see how people with various styles would approach the problem. If the physiotherapist has an insight into these various styles, he can match to what is important for that patient. This can have a positive influence on motivation during the physiotherapy treatment.

10.2.3 Feedback

Besides motivation, feedback also defines to a large extent whether learning processes are successful or not. Without adequate feedback of information, learning processes are much more laborious. Feedback is essential to achieve learning. Without feedback it is not possible to obtain information about the success or failure of learning the motor skill. It enables us to control the motor skill in such a manner that it produces the desired result on a subsequent attempt.

Feedback is obtained on the basis of sensual perception. The following systems can be addressed:

- Auditive system
- Visual system
- Extero- and proprioceptive system
- Olfactory system (smell)
- Cognitive system

A typical characteristic in patients with a CNS disorder is that there is generally an impairment in one or more of these feedback systems. Tests provide information about which system is still functioning adequately. Also they provide relevant information about what the residual capacity is of the impaired feedback system. This increases the chance of successful motor learning of the chosen skills. The feedback that is obtained about the action can be intrinsic or extrinsic:

- Intrinsic: the patient with a CNS disorder is able to obtain feedback about his actions.
- Extrinsic: the therapist gives feedback about the motor skill.

Example from Practice 10.4

Mike wants to learn to play tennis. He has played soccer for many years and is a great fan of sports. He has also watched a lot of tennis. On that basis, combined with his ball handling skills from playing soccer, he has decided to just go and play and not to take tennis lessons (doer and implicit learning).

Once on the court, he starts with serving. He has seen on TV how this should go (visual system) and tries to imitate it. The first time the ball lands in the net and the second time it goes over the net but does not land in the service box. The third time it lands properly. Mike is, in fact, able to modify the parameters in such a way from the feedback he gets (proprioceptive, exteroceptive, and visual) that on the third time the ball is served successfully. But, not yet effectively enough, he is still having to think about it too much (cognitive phase).

After a number of weeks of playing tennis, it is all going much better; his service goes in nine of the ten times (autonomous phase), and as such he is already much better prepared for the return. The funny thing is that if he serves the ball badly, he often knows that in advance (associative phase).

10.2.4 Various Phases in Motor Learning

In the example with Mike, it becomes clear that various phases in motor learning can be distinguished:

1. Cognitive phase: you have to think about what you are doing.
2. Associative phase: at this stage the difference becomes clear between an incorrect and correct execution of the skill. This happens on the basis of internal feedback.
3. Autonomous phase: the action has been automated and errors can be recovered during the activity. Double tasks can possibly be offered.

The learning of motor skills is different for each individual. One person needs more time than someone else. Motivational aspects play an important role in this. Learning a motor skill is in part determined by the chosen learning strategy.

10.2.5 Different Motor Learning Strategies

We will provide an overview of the many different motor learning strategies. The trick is to use them consciously, in order thus to make motor learning efficiency as effective as possible. It concerns the question: Why do you deploy a particular learning strategy, and what feedback systems are you using within the chosen learning strategy? Why a particular learning strategy is chosen and which feedback system is being brought into play will be made clear with examples from practice.

- **Making Explicit**

Making explicit means by means of self-instruction attempting to engrain the skill at a conscious level. It has been shown in studies that consciously implemented learning strategies can be effective, for example, with Parkinson's patients who have to relearn the transfers (Kamsma 2004). The transfers were subdivided in sub-skills (see ► Chap. 2). The sub-skills were learned step by step and the patient himself had to verbalize the steps while doing them. In this way the transfer was engrained consciously, therefore independent of automation. In comparison with the control group, this approach proved to be more effective.

This strategy was possible because the patient group was cognitively able to reproduce the steps. Besides self-instruction, it is therefore also a cognitive strategy. The feedback system that is brought into play within the chosen learning strategy is cognition.

Moreover, you can bring other feedback systems into play within the chosen learning strategy, such as auditive and visual cues, because it is known that many Parkinson's patients react well to this.

Example from Practice 10.5

LSVT

LSVT stands for the *Lee Silverman Voice Treatment*, which has now been developed in two forms for Parkinson's patients. This learning strategy was first developed as LSVT-LOUD by and for speech therapists. Through it the patient learns to speak louder and more clearly without starting to shout. Parkinson's patients improved in terms of their voice volume and the monotonous voice was also positively influenced.

The principles from this method were then applied to motor skills in the LSVT-BIG. The shuffling steps that the Parkinson's patient makes have become, in his perception, normal movement. At a conscious level, the patient should take larger steps (but not start running), which can be supported by offering auditive rhythmic cues. From experimental research (Farley and Koshland 2005), it seems that by using this method the walking pace and step length increase.

Patients with Parkinson's must therefore consciously continue to use LSVT-BIG, because the actual automatizing of this is the problem here. Executing at a conscious level corresponds to the method that Kamsma has scientifically shown to be effective in relation to improving the transfers of standing up and getting in and out of bed.

Within this learning strategy, the cognitive feedback system (deploying continuously at the conscious level) and the auditive feedback system are used to sustain the movement (◘ Fig. 10.3).

◘ **Fig. 10.3** Large range of motion to create awareness of movement in Parkinson's patient

Visual Learning

Visual learning is learning by means of pictures, mirror, imitating, etc. People learn in part by looking at how other people do something. It is often simpler than explaining how a skill works. Physiotherapists are inclined to give a lot of verbal information. Studies have shown however that this is less effective (Nijhuis-van der Sanden 2006).

Mirrortherapy used a mirror with the goal being to reduce phantom pain in amputation patients. By using the mirror, the amputation patient thought he still had the leg. The brain was, as it were, fooled. Thanks to this intervention, the phantom pain reduced or even disappeared completely.

Example from Practice 10.6

Mr. T. has a neglect as a result of a brain infarction in the right hemisphere. He has a good selectivity of movement in the arm, but it is not used as a result of the predominating motor neglect. We decided to use mirror therapy.

While practicing with the mirror, there is a type of «learning by imitation» strategy. That means that the patient sees the movement of his (virtual) neglected arm in the mirror. Because of this, the brain receives a positive visual feedback about this movement. The patient experiences how the movement could look.

Through the use of the movement image (virtual reality), networks are activated that play an important role in learning the movement. The parietal cortex, the supplementary motor cortex, and even spinal networks are activated by this virtual reality. In these areas, the integration takes place of both the conscious image and the unconscious preparation for and execution of the motor program (*mental imagery*).

We practiced for 6 weeks, three times per week, and evaluated the treatment session with the VAS. We asked his spouse to score the following question: «How do you feel that your partner is using his arm? 0 is not at all and 10 is optimal use under all circumstances.» She scored 3. After 6 weeks of practicing, the score was between 5 and 6. In short, it was worth the effort Mr. T. did not however personally experience very much.

The visual system is often frequently brought into play by way of compensation for the sensory system. And vice versa, people with a visual handicap actually make more use of the sensory system.

In the case described of a neglect, a mirror can be chosen as an aid. Another obvious strategy for a neglect is scanning techniques. In this the visual and cognitive feedback systems are brought into play; the patient is taught to scan (i.e., to observe the space) and at the same time to modify his behavior such that he continues to always use this technique.

Perceptual Learning

Perceptual learning means want learning by feeling (*hands on*). Learning by feeling is especially suitable when the patient has adequate proprio- and exteroceptive feedback. You allow someone to gain sensorimotor experience from the assumption that he can later reproduce it.

For people with a lesion in, for example, the cerebellum, the muscle-tone regulation is impaired. The hands-on method is then a good strategy for positively influencing the motion sensation and thereby striving to achieve a better quality of movement. Techniques from the NDT, such as guiding and facilitating, can be applied to optimize this movement sensation.

Looking for Solutions: Oneself Within One's Own Movement Repertoire (Hands Off)

When someone has good illness awareness and is actively seeking to find out what his own capabilities are, it is a good idea to make use of that. Their safety must be guaranteed and the limits monitored. The patient must also have an adequate intrinsic feedback system, to be able to control his own actions. A well-functioning declarative memory is necessary, so that what is learned can be stored in the cortex and can be reproduced subsequently.

The aspiration here is implicit learning, where you assume that the patient has adequate and sufficient feedback systems, in order to be able to achieve successful motor learning.

Finding the Limits of One's Own (In)abilities

Sometimes someone needs to be stimulated to find the limits of his own (in)abilities. There can be various reasons for choosing this approach:

1. There can be an underlying depression, as a result of which someone does not get round to activities (depressions occur in CNS disorders; see ► Chap. 5).
2. There is a reduction in the ability to take the initiative resulting from the CNS disorder, as a result of which the patient needs an external motivator in order to undertake activities.
3. Someone can feel anxious because of the reduction in the motor abilities he has as a result of the CNS disorder.

From these points we can conclude that the lack of cognitive control, namely, the ability to take the initiative to undertake activities is impaired, can probably be resolved by external guidance.

Also it is possible in consultation with the patient to set up a structured daily program so that «taking the initiative to undertake an activity» is taken over by an external factor, namely, a daily program on paper.

Auditive or Visual Cues

There has been much research into the use of auditive and visual cues in Parkinson's patients (Benecke et al. 1986; Nieuwboer et al. 2004). It is known that using *auditive* cues for Parkinson's patients has a positive effect during the auditive stimulation walking speed, pace frequency, and step length. The hope is that these positive effects remain by means of exercise. It is also possible to teach the patient the strategy of auditively accompanying himself, so that the effects are preserved. In practice this appears to be disappointing.

It is known that *visual* cues, such as a line on the ground or focusing the attention on an object, can reduce start problems in Parkinson's patients.

Feedforward Feedback

Feedforward feedback is a strategy where you have the person state what has to happen by means of feedforward. Using feedback he gets a reflection about his own actions. This can be done practically having the patient asking himself each time the following questions:

1. What am I going to do?
2. How am I going to do it?
3. What do I need for that?
4. How did it go?

This cognitive strategy can be used if someone, on the basis of neuropsychological impairments, has difficulty getting his activities in the right order of action. The strategy can also be applied if someone is lacking overview in complex skills.

This strategy demands a high degree of discipline from both the person who has to carry it out and from the therapist. In this context the caveat is that the application of this strategy cannot be generalized automatically to skills that are not practiced in the therapy setting.

Within this learning strategy, cognitive action is brought into play when there is an impairment in the ability to work in a structured fashion on the basis of an impairment in the executive function.

Example from Practice 10.7

Stephen is a young boy who has difficulty in introducing structure into his actions. During the craft lessons at school, he makes a big mess; getting dressed at home is successful with guidance but takes a long time, and eating nicely is very difficult.

For craft lessons at school, the decision is made to use the «bears method.» Stephen gets four pictograms showing a bear. Each pictogram has a number. The numbers stand for: (1) What am I going to do? (2) How am I going to do it? (3) What do I need for that? (4) How did it go?

After 6 weeks of consistent use of this strategy, there is a visible result. What he makes in the craft lesson is better, and after the lesson, there is much less mess.

At home on the other hand, he still has the same problems with getting dressed and eating. Here too, the bears methods should be introduced.

10.2.6 Learning Strategies to Reduce the Influence of Cognitive Problems

Using learning strategies to reduce the influence of cognitive problems is an effective method. For that it is necessary firstly to make an appraisal of the neuropsychological impairments that are the most limiting for the execution of the motor activity. Then the learning strategy can be matched to that. Example from Practice 10.8 makes that clear.

Example from Practice 10.8

Mr. B. has a right hemisphere lesion. There is severe spastic hemiparesis, and on the basis of neuropsychological testing, the following problems have been determined, among other things:

- Impulsivity
- Restricted disease awareness
- Reduced specific attention
- Perception problems

In spite of the severe hemiparesis, using the stairs is being practiced. On the basis of the neuropsychological problems, we made a deliberate choice to use the following learning strategy:

- Feedforward feedback
- Self-instruction while walking up and down stairs

This learning strategy has been deliberately chosen because feedforward feedback and the self-instruction of walking up and down stairs ensure that there is more task orientation. The motor actions are also verbally accompanied instead of only visually. Using this motor learning strategy, we reduce the described problems, in order to achieve an optimal learning climate.

10.2.7 Mental Training

The term mental training has become familiar mostly because of top athletes. A sprinter visualizes, for example, the 500-m sprint that he will run and in his mind sees each step that he takes. MRI research has shown that the control circuits in the brain that are associated with that movement actually show more activity when the movement is visualized. This benefits the movement.

Through mental training a patient can himself exert influence on those movements that have to be practiced. If we look at which aspects of the CoFSSS could be subject to this influence, then the most likely would seem to be the coordination of movement. Moreover, it is possible by using mental training that influence is exerted on cognition and emotion. We do have to bear in mind that the measurement of changes in the field of emotions and cognition can be difficult (Braun et al. 2010). Mental training could, for example, be applied to reduce the fear of moving.

The learning strategy offered is mental training, and the feedback systems that are brought into play are cognition and vision.

Supplementary Information

F. van der Brugge, *Neurorehabilitation for Central Nervous System Disorders*,
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Appendix: Observation Form (Central Nervous System (CNS) Disorders)

Name: ______________________________

Date of birth: __________________________

Medical diagnosis: ______________________

Date of observation: _____________________

Mobility

			Myogenic	Collagen	Arthrogenic
		Wrist			
Leg	Left/right	Hip			
		Knee			
		Ankle			

Sensation

Spinothalamic sensation

Sense of touch: ____

Pain sensation: ____

Temperature sensation: ____

Spinocerebellar sensation: ______________________________________

Position sensation: ____

Movement sensation: ____

Vibration: ____

The extinction: ____

The two-point discrimination: ___________________________________

Muscle Tone

Hypertonia ____

Hypotonia ____

Is there any muscle-tone dysregulation (spasticity, rigidity, or paratonia)? ________________

Is this present in an impeding manner (e.g., pain, subtraction paresis), and can this be influenced manually, medicinally, or invasively? ______________________________

Clinimetry

Barthel Index

Date				
Score				

Interpretation of scores:
- 0–4 = very severely restricted
- 5–9 = severely restricted
- 0–14 = moderately restricted
- 15–18 = slightly restricted
- 19–20 = ADL independent

Berg Balance Scale

Date				
Score				

Interpretation of score:
- A score of <45 points means that there is an increased risk of a fall.

Motricity Index

Date				
Score				

- **10-Meter Walking Test**

Date				
Score				

Patient's Stamina

Score on Ästrand Test				
Date				
Score				

Score of 6-min Walking Test				
Date				
Score				

Complete Motor Skills Viewed from the Motor Control Model

Within which facets of the motor control model do you see problems, and which of those will be the most important starting point for treatment?

At cognitive level	Action planning
	Motor planning
At motor level	Motor programming
	Parameterization
	Motor initiation
At effectuation level	Peripheral nerve transmission
	Strength generation
Cognitive	Feedback on own actions

- **Motor Learning**

Which form of motor learning fits best in your view with the learning strategy of this unique person?

- Explicit learning (knowledge of performance; KP); with this form of motor learning the therapist indicates what and how that has to happen. Which feedback system are you bringing into play in order to allow the patient to benefit optimally from your instructions?
- Implicit learning (knowledge of results; KR); with this form of motor learning the patient seeks his own solutions within his adaptive capacity. Which feedback system are you bringing into play now in order to allow the patient to benefit optimally from his own learning efficiency?

- **Feedback**

Which feedback system is best brought into play for this patient?

- Exteroceptive
- Proprioceptive
- Auditive
- Visual
- Cognitive.

Cognitive Functioning

Indicate in the table your first impression about any cognitive function impairments that might exist.

Impulsive	
Attentive	
Is aware of surroundings	
Can express himself well verbally	
Memory is in order	
Logical order of actions	
Anticipates changes	

Can you reduce the cognitive function impairments that may exist as much as possible with the learning strategy you have chosen? ______________________________

Burden and Resilience

What is the balance of burden and resilience with respect to each other? Place this within the influencing of fatigue.

____

Help Request from Question Patient and Those Directly Involved

Describe this request for help from both the patient and those directly involved.

____

____

Working Hypothesis

Write a working hypothesis about what you see as problems in this patient and how you as a physiotherapist can help

____

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