

**RHYTHMICAL EXERCISES AS TOOLS FOR REHABILITATION FOLLOWING  
CEREBELLAR STROKE**

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<p>Strokes will be an enormous social and economic burden for society in the future. After a stroke, the quality of life is more or less reduced. Recent research has indicated a close link between musical, auditory, cognitive, and motor processes in the brain. Impairments caused by stroke in the cerebellum are rather different than in strokes in one hemisphere of the brain. Timing, coordination, the strength of movements, and problems with balance are the most common impairments in patients with stroke in cerebellum. The cerebellum is connected with such cognitive functions as working memory, spatial learning, attention, speech, and the emotions.</p> <p>External auditory cues have been demonstrated to facilitate movements and vocal output. Prior studies have shown that stroke patients can modify the motor impairments when the motor system is directly influenced through the auditory system. There is an evident shortage of research on cases where auditory, tactile, and visual stimuli are combined simultaneously as sensory activation for rehabilitation of movements.</p> <p>The study addresses this lack by experimenting with combining external, rhythmical auditory and the patient's own rhythmical vocal output for activating the motor system as part of the physiotherapy process after a cerebellum stroke. Rhymes and rhythmical speech may help the patient in drumming with the hands, or while moving with music by helping the timing of movements. Ten rehabilitation sessions with rhythmic exercises showed that the patient benefited from simultaneous combination of movement, speech, and rhythm. The important phenomena rose up in this study; fatigue, the founded tools to delete it during the therapy, and the phases of upper limb movements in the rhythmical tools. Authentic video excerpts have been used as primary data for to illustrate the improvement in the client's condition.</p>	
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## 1 INTRODUCTION

### 1.1 Stroke rehabilitation and music therapy

Strokes pose a growing future problem for the health care system worldwide. The amount of strokes is rising in correlation with the increasing amount of aged people. Public health care in Finland seems to have the same problem as the rest of the world: the financial investments for rehabilitation are inadequate. Therefore, the rehabilitation projects lack time and participation of various therapists is diminished. This study is intended to encourage therapists in the rehabilitation field to find and adopt activating tools from other fields of therapy. The study presents a physiotherapist's own experiences of combining the elements of speech therapy and music therapy in her work.

In Finland there were 17,000 stroke cases in 2007. The general term *stroke* refers to damage to the brain induced by either an ischemic state (blockage in the artery) or rupture of a blood vessel. The largest number portion of stroke patients (70-80 %) have stroke in their middle cerebral artery indicating problems in one hemisphere of brain (Särkämö 2011, 10). Economically, strokes are the third most expensive disease in Finland, as approximately 40 percent of stroke patients need intensive rehabilitation in the acute phase and as many as 30 000 stroke patients need continuous rehabilitation. About 50 percent of stroke victims suffer permanent sensory and motor impairments, and around 75 percent of all acute stroke cases will have sensory and motor impairment with upper and/or lower limb paralysis. (Aivohalvaus- ja dysfasialiitto ry, 2009; Kaste et al., 2006.)

Complex motor and cognitive impairments are very common after a stroke. The extent of functional impairments depends on the extent of damage to the brain. Simultaneously, the patient's urge for rehabilitation directly correlates with the extent and severity of these functional impairments.

## 1.2 Adopting tools from music therapy

Rehabilitation is a cognitive process in which memory and motivation play an important part in recovery (Shumway-Cook and Woollacott 2001, 25). External auditory cues have been demonstrated to facilitate movements and vocal output. It has been possible to modify the motor impairments of stroke patients by directly influencing the motor system through the auditory system. Rhythm may permit a time ordered pattern according to which the motor-impaired person is able to retrain his movements (Tomaino, 2009b). Research has found evidence at the brain stem level for the existence of audio-motor pathways via reticulospinal connections. The auditory system — a fast and precise processor of temporal information — projects into the motor structures in the brain, and is able to create entrainment between the rhythmic signal and the motor response (Thaut and Abiru, 2010).

Neurocognitively oriented music therapy using a combination of verbal elements (rhymes, texts of songs) for the motor performance is able to develop the working memory (Äystö 2005). The results of a broad Finnish research project indicate that music induces long-term changes in cognition that are indexed by enhanced recovery of focused attention and verbal memory. The researchers found that relaxing music enhances the recovery of cardiovascular and respiratory functions and decreases cortisol levels after stress. It was also reported that listening to music increases dopamine synthesis in the brain, which is crucial for mediating arousal, emotion, reward, motivation, memory, attention and executive functioning (Särkämö et al., 2008).

Music structures and increases the experience and accelerates the effect of bodily movement (Nordorff-Robbins 1979, 27). In motor control the same areas in the brain are activated as those that are activated in processing language, auditory perception, and memory. Music and rhythm activates these systems and drive complex patterns of interaction among them. Some scientists have speculated that Broca's area supports the appropriate timing, sequencing, and knowledge of rules that are common and essential to music, speech, and movement. Through such learning (rhythm, language, movement, memory), auditory and motor areas in the brain grow larger and interact more efficiently (Thaut and McIntosh, 2010).

The Broca's area, the area of mirror neurons, is shown to be important for understanding motor actions. The mirror neurons are motor neurons, which react when a person is motor activated or when he or she follows another person's movements. Due to the effect of mirror neurons, the observer will experience the same activation in his or her motor neural network as the moving person has in the activated motor areas. Mirror neurons have visual-motor and/or audio-motor attributes. Mirror neurons are therefore significant in learning motor skills. (Johansson, 2008.)

### **1.3 Combining clinical experience with theoretical research**

The Social Insurance Institution in Finland (KELA) purchases medical rehabilitation for patients with severe disabilities. KELA requires quality for the rehabilitation acquired from the music therapists, physiotherapists, and service providers in related fields. The content of the physiotherapy and music therapy provided must be specified as being based either on scientific research or on other large experience (KELA, 2012).

Karppi (2003) underlines the clinical experience as an important foundation for qualified physiotherapy. The course of action and methods chosen in the rehabilitation are partly evidence based, partly they are chosen based on the experience of the clinical work. Neither the clinical experience nor the researched knowledge are by themselves enough, but the excellent therapist must combine them so as to provide the patient with the best possible benefit. (Karppi 2003, pp. 20-22.)

34 years of clinical experience in the rehabilitation field as a physiotherapist, combined with my longstanding interest in music therapy, led me to use multisensory activation for rehabilitation of patients who have had strokes in the cerebellum. I studied the therapy process with the aim of combining music therapy resources in the rehabilitation in such a way that the music's therapeutic effects and the patient's motor-sensory sensations can work together to accelerate the reformation and reorganization of the stroke victim's brain network. I describe and inspect the music therapy process of the cerebellar patient and the phenomena arising in the process, and examine the literature on strokes, movements, music therapy. As a physiotherapist, the identity of my profession is the basis of my

working in my clinical work. As a music therapist, I describe the methods and choices in the ten music therapy sessions, and report on what I learned from those sessions.

#### **1.4 Rehabilitation of cerebellar stroke patients**

There are plentiful studies that concern rehabilitation of stroke patients with music therapy, but mostly these are reports of using rhythmical stimuli to activate the patient to walk or to regain the use of a paralyzed arm. Earlier studies have shown that stroke patients can modify the motor impairments when the motor system is directly influenced through the auditory system. There is an evident lack of research on cases where auditory, tactile, and visual stimuli are combined simultaneously as sensory activation for rehabilitation of movements and speech. Additionally, there are few studies on cases involving the rehabilitation of cerebellar stroke victims.

My decision to select this particular topic arose out of my personal interest in finding alternative approaches to rehabilitation of this particular type of stroke patient. Survivors of cerebellar strokes face many functionality problems in their daily lives. My work with Jussi, the cerebellar patient introduced later in this thesis, showed me the diversity of his problems. His problems were not so obvious and substantial that he needed ongoing hospital treatment, but they severely impeded his daily life. Timing, coordination, strength of movements, and problems with balance are the most common impairments in patients with stroke in cerebellum. The cerebellum is related to such cognitive functions as working memory, attention, spatial learning, speech and emotions. The patient's dysfunctional cerebellum created problems in timing movements, such as correctly activating the muscles needed to jumping over a low barrier or to kick a ball. He had problems in pronouncing complicated words, and in finding the appropriate words and expressions for what he wanted to say, and this was exacerbated by problems with his working memory. He had difficulties in understanding written texts, and was unable to concentrate on walking while simultaneously taking account of his immediate environment, such as the movement of traffic. Although these problems described were not life threatening, they did significantly decrease his quality of life and led to low self-esteem. The timing of movements and speech and the coordination of bodily movements, in short, needed improvement through neurocognitive rehabilitation.

The experimental trial, consisting of ten music therapy sessions, were conducted by me a year before I began the Master's programme at the University of Jyväskylä. In the trial I combined the visual, tactile, and auditive stimuli with the cerebellar stroke patient's own rhythmical speech and motor stimuli to improve his motor performance. The trial proved to be a successful and positive experience for both the patient and the therapist. I selected the material for the ten sessions, notes and authentic video clips for the clinical case study, Gaining in-depth familiarity with the literature led me into in the very interesting world of shaping movements with music, rhythm, and rhythmical speech. Moreover, it introduced me to more new aspects and invited me to explore still further. As the research progressed it became increasingly important to gain a sound understanding of the various elements that influenced the motives and phenomena of the rehabilitation process.

## 1.5 Overview

The remainder of this chapter introduces and justifies the topic. Chapter two consists of a literature review of the relevant material. Based on the literature and on my own clinical experiences, I have formulated my conception of rhythmical multi-stimulating music therapy as the framework shown schematically at the end of the chapter. Chapter three sets out the aims of the study and outlines the methodology, methods, and data. Here also I introduce the patient and his goals and wishes for the therapy sessions and his capability of functioning in everyday life. The research design is also presented, and the chapter concludes with a discussion of the problem field of the cerebellar stroke patient and the music therapy-oriented rehabilitation. In Chapter four the advantages of multisensory activation in the rhythm-aided rehabilitation process are introduced, and some issues in the literature on rhythm and motor function accuracy are discussed. There were also some problems in the music therapy sessions, and these are discussed in this chapter. One of the problems, namely fatigue, proved to raise highly interesting questions in the rehabilitation work.

The validity and reliability of the thesis findings are discussed in Chapter five, where I also include some ideas on improving my therapy methods and combining further music therapy elements in physiotherapy. The chapter describes the music therapy clinical

training process as my own learning process, and in this context I evaluate the clinical training process and my work and own strengths and areas for further improvement as a music therapist.

Overall this study highlights the importance of seeking efficient and effective rehabilitation methods for improving the life quality of the ever-increasing number of cerebellum stroke patient and their ability to participate in society. Furthermore, it demonstrates the value of a multi-disciplinary approach and hopefully provides a platform for further research and day-to-day rehabilitation work in practice.

## 2 STROKES AND POST-STROKE THERAPIES

In this chapter the main concepts concerning strokes and stroke therapies will be introduced and discussed. The discussion of strokes is mainly focussed on the cerebellum, with cerebrum strokes and their rehabilitative treatment being discussed only briefly.

In Finland there were 17 000 cases of ischemic stroke in the adult population in 2007 (Kansanterveyslaitos 2007). Every year 14 000 Finnish people suffer a stroke, which is now the third most common cause of death in Finland, accounting for around 5000 fatalities a year. With the increasing standard of living people are living longer, and stroke is a problem for old people in particular. It has been predicted that with growing age the cases of strokes also are growing and that year 2020, in Finland would 21000 people get stroke. Half of stroke patients are left permanently disabled. Every third victim recovers completely, and one-third of stroke- patients are left with speech impairments. (Aivohalvaus- ja dysfasialiitto ry, 2009.)

A stroke is caused by the interruption of the blood supply to the brain, usually because a blood vessel bursts or is blocked by a clot. This cuts off the supply of oxygen and nutrients, causing damage to the brain tissue. The most common symptom of stroke is sudden weakness or numbness of the face or of an arm or leg, most often on only one side of the body. Other symptoms include confusion, difficulty speaking or understanding speech, difficulty seeing in one or both eyes, difficulty walking, dizziness, loss of balance or coordination, severe headache with no known cause, and fainting or unconsciousness. The effects of a stroke depend on which part of the brain is injured and how severely it is affected. A very severe stroke can cause sudden death. In all WHO regions, in all ages mortally per 100.000 people in year 2004 was: males in Finland 46.8, in Sweden 41.9, in France 31.3. Mortally was in previous context females in Finland 38.1, in Sweden 36.7, and in France 24.8. (WHO, 2012.)

A stroke is a term for damage to the brain induced by either an ischemic state (blockage in the artery) or rupture of a blood vessel. The most portion of stroke patients (70-80 %) have stroke in their middle cerebral artery indicating problems in one hemisphere of brain

(Särkämö, 2011). Various kinds of motor and cognitive impairments are very common after a stroke. The extent of functional impairments is depending of the extent of damages in the brain.

In her doctoral study of the functions affected by stroke, Pyöriä (2007) found that over 60 % of patients with stroke have cognitive deficits, with impaired memory, orientation, linguistic functions or attention. Memory is a complex phenomenon. Learning skills are totally dependent on the capacity to retain information about ongoing actions and events. A lesion in the central nervous system (CNS) produces primary neuromuscular impairments, such as paresis, abnormalities in muscle tone and abnormal timing of muscle activation. Disruption in the timing of muscle activation contributes to movement difficulties in people with stroke. The initiation of movement is delayed, the rate of force development is slowed, muscle contraction time is prolonged, and the timing of the activation of antagonists relative to agonists can be disrupted in patients with stroke. Unilateral muscle weakness can vary in severity from total muscular activity loss, which is termed hemiplegia, or severe loss of muscle activity, hemiparesis. (Pyöriä, 2007.)

Somatosensory impairments are common in stroke patients. Up to 60 % of stroke patients have loss of tactile and proprioceptive sensation following brain lesions. Loss of discrete sensation, most typically from the limbs and the face, represents a failure of sensory impulses to reach the relevant areas of the brain from the various sense organs of skin, joints, muscles, ears, eyes and mouth. That is, sensory inputs neither reach consciousness nor do they appear to play a role in the motor output. (Carr and Shephard, 2002.)

## **2.1 Cerebellar stroke**

A stroke in the cerebellum has effects in several areas of a person's functionally skills, including motor performance, timekeeping, and working memory. Evidence of the role of the cerebellum comes from anatomical, clinical and neuroimaging data. It has long been known that the cerebellum is an important component of the neural underpinnings of the control of movements. It is part of the "cognitive" networks with prefrontal and parietal association cortices. The precise role of the cerebellum in cognitive tasks is not yet fully understood, however. (Stoodley, 2011.)

The cerebellar stroke patient has typical deficiencies in motoric performance. He or she may have difficulty holding a pen to write or a knife to cut, both of which involve the sustaining of muscle force and the generation of repetitive and rapid changes. In individuals with relatively mild cerebellar signs, walking may be faster than appropriate, with large steps and a relatively wide base during double support. With cerebellar lesions the sequence of muscle activations can be largely preserved, but is dysfunctional in terms of timing and the required fast built-up of muscle activity and therefore the proper scaling of force. The lack of consistency in movement is common following cerebellar lesions. The person with cerebellar dysfunction typically has difficulty with initiating movements, and there is usually evidence of dysmetria at the end of the movement. The recognition of movement, awareness of its direction and of position in space, may be impaired. It may be possible for a person to recognize limb movement but not the position of the limb or the direction of the movement. These deficits are more obvious distally than proximally. The individual with cerebellar dysfunction may perform the joint components independently of each other, producing a “decomposed” movement. There may be a failure to brace joints against forces generated by movement more distally. (Carr and Shephard, 2002.)

Harrington et al. (2004) discuss the role of the cerebellum as timekeeper, and cast doubt on the proposal that the cerebellum would regulate a common timekeeping mechanism. They describe the most common impairments of patients with cerebellar strokes and inspected 21 such patients, and used a control group of 30 healthy age- and education-matched subjects. They tested for functions such as performance of daily activities, gait and balance, rapid alternating movements of the hand and foot, dysmetria, nystagmus and dysarthria. They found that the severity of symptoms in the upper limb was worse on the side on which the damage occurred (i.e. on the ipsilateral side) than on the contralateral limb. Over 40% of the patients were impaired in a test (part A of the Trail Making Test, TMT), which measures visual-scanning and motor speed. 20-30% of patients were impaired on part B of the same test, which assesses cognitive flexibility and executive function of working memory. Maximum tapping speed and fine motor coordination were found also to be lower in the ipsilateral hand than in the contralateral limb. Harrington et al. pointed out that simultaneous use of both hands remedied the work of the impaired hand in tasks such as the clock variability task. Improvements in clock variability in the impaired limb during bimanual movements may reflect an emergent property of the strong coupling

of the two hands, which enhances stability and reduces variability in the motor system. (Harrington et al., 2004.)

Characteristic impairments sustained by stroke patients include: *nystagmus*, which consists of involuntary sideways movements of the eyes (American Nystagmus Network 2012); *dysmetria*, concerning problems of neurological patients in coordinating the agonist-antagonist muscle activity with (Harrington et al. 2004). *Dyssynergy*, i.e. “decomposition of movement”, a lack of coordination between not only the agonist-antagonist but also other synergist muscles, resulting in an absence of the normally smooth, sequential performance of various components of an action. Errors occur in the relative timing of segmental components of multi-joint movements. (Carr and Shephard, 2002.) *Dysarthria* occurs when the muscles of the mouth, face, and respiratory system become weak, move slowly, or do not move at all after a stroke or other brain injury. The type and severity of dysarthria depends on which area of the nervous system is affected. (American Speech-Language-Hearing Association, 2012.)

## **2.2 Cerebellar functions and rehabilitation of stroke victims**

The cerebellum forms reciprocal links with prefrontal and parietal association cortices via cerebello- cortical and cortico-ponto-cerebellar loops. Findings in several studies reaffirms the already-established view that the cerebellum participates in distributed networks involved in both sensimotor and higher-level functions. The cerebellum is shown to be active during visual paired associate learning and retrieval, and to have a role in the visual coordination of movement. Both verbal and non-verbal working memory tasks activate the cerebellum. The cerebellum is also believed to be involved during both the encoding and retrieval phases of short-terms memory tasks. According to Stoodley (2011), the cerebellum seems to activate during processing of emotionally relevant stimuli, as in when empathy is expressed for another person’s pain, or in response to negative emotional stimuli. The lack of emotional modulation seen in some cerebellar patients may be a sign that the cerebellum would be important to the modulation of mood and emotion, in relation to movement.

This section first discusses the current care summary for the professions involved in post-stroke rehabilitation. Secondly, I describe the physiotherapy of stroke patients in Finland. The section concludes with a discussion of physiotherapy for victims of cerebellar stroke.

According to a working group appointed by the Finnish Medical Society Duodecim and the Finnish Neurological Society, effective treatment of stroke patients can significantly reduce disability. The key steps to improving the outcome are early diagnosis of stroke symptoms, access to thrombolytic therapy, and acute care in a dedicated stroke unit where assessment and rehabilitation are carried out by a multi-professional rehabilitation team. In the field of physiotherapy, the working group recommended that motoric rehabilitating will become more efficient by increasing the intensity of physiotherapy. The crucial consideration for recovery is the early start for the rehabilitation and training the tasks and attributes that are needed. Walking on a treadmill may increase the ability to walk independently; it may also increase walking speed. Constraint induced movement therapy, CIMT may increase the motor performance of hand and the autonomy of the patient. The working group found occupational therapies to be effective in rehabilitating the performance of everyday activities. The working group found that speech therapy may be useful in the early state rehabilitation of the aphasia. Additionally, the active swallowing therapy is found to be helpful in improving the swallowing function and diminishing the risks of complications. Finally, in the field of neuropsychological rehabilitation, the working group recommended a focus on training the visuospatial impairments and increased attention to the identification of symptoms in this area. The rehabilitation of attention impairments, memory recall, and executive disturbance may also be effective in preventing permanent disablement. (Current Care Summary, 2011.)

The most widely used neurofacilitation method is the Bobath therapy developed by Berta and Karel Bobath. This approach has influenced physiotherapy practice worldwide, and is also the most frequently used treatment in Finland. The treatment centers round the facilitation of corrected movement by a physiotherapist who handles the patient's body manually. Particular emphasis is placed on facilitating normal afferent inputs and normal movement patterns, while minimizing the incidence of abnormal movements. (Pyöriä, 2007.) Tyson and Selley (2007) described the working methods of physiotherapists in the United Kingdom. They found that as in Finland, the Bobath method as the most predominant approach of stroke physiotherapy. They argued that in the Bobath method

patients remain fairly passive: functional tasks are practiced, but this is predominantly in the treatment session under the physiotherapists' close supervision. Most physiotherapists perceived their own practice to be eclectic, but the interventions used followed a traditional Bobath model. The patients of 'eclectic' physiotherapists were found to be older than average. (Tyson and Selley, 2007.)

Motor relearning is a new clinical method developed by Carr and Shephard (1985). One such approach to retraining is a task-oriented approach to clinical intervention, which is based on new theories of motor control and learning. Pyöriä (2007) reports the method of Carr and Shephard of assuming that patients learn by actively attempting to solve the problems inherent in a functional task, rather than repeatedly practicing normal patterns of movement. Adaptation to changes in the environmental context is reported to be a critical component of recovery of function. The results have shown that the patients who were treated with the motor relearning program remained in the hospital for less time and improved their motor performance significantly more than those treated with Bobath therapy. Recent developments of the Bobath approach include a systems model of motor control and principles of motor learning, but the use of equipment has not been incorporated into clinical practice. The nature and extent of the cognitive deficiency must be considered in physiotherapy if stroke rehabilitation is to be a learning process with the goal of improving is the patients' own functioning outside therapy sessions. Several studies have found that patients treated on the Motor relearning program (MRP) or a Task-oriented approach improved their motor performance and sitting balance significantly more than patients treated with Bobath therapy. (Pyöriä, 2007.)

"Physiotherapists are not so eclectic in their methods as they wish to be. An alternative explanation is that although physiotherapists feel that they should use 'other methods' the barriers to implementing them into existing models of service delivery are too great so in practice they maintain the models of service delivery with which they are familiar and comfortable".(Tyson and Selley 2007). There is proven effectiveness in bilateral movements during the sub-acute and chronic phases of recovery, either on their own or in combination with auxiliary sensory feedback in stroke rehabilitation protocols. These protocols involved either functional tasks or repetitive arm movements. (Stewart et al., 2006.)

## 2.3 Music therapy for cerebellar stroke patients

There are few guidelines in the literature for rehabilitation of cerebellar stroke survivors. Each therapist has to consider the structure of the process based on the assessments of insufficiencies and strengths of patient. A very important role for the rehabilitation process is to stimulate the activity of the patient him- or herself. The therapist has to gain the trust and cooperation of the patient. The recovery of normal functioning after stroke is a learning process, which calls not only for physical but also cognitive and mental actions.

According to Carr and Shephard (2002), as the patient gains renewed control over a particular action there are several ways in which the therapist may increase complexity so as to push the individual to the limits of his or her effective performance. To increase the task complexity, the therapist may withdraw external guidance and control, reduce the possibilities for support through upper limbs, and encourage increased amplitude of movements. The tasks become even more demanding when the therapist adds in alterations, changes in amplitudes, directions and forces of movements. The therapy should include increased balance requirements, complex movements stopped immediately on request, and the therapy could reduce additional demands of the action (e.g. by speaking during performance) and to encourage automaticity. Jumping actions provide the opportunity to practice a rapid generation of force, with associated synergic movements, and for switching between concentric and eccentric muscle action. (Carr and Shephard 2002, pp. 212-224.)

Music therapy is a form of rehabilitation and treatment using various elements of music (rhythm, harmony, melody, timbre, dynamic etc.) as an essential implement of interaction for to achieve the individually laid goals. It may be carried out one-to-one or with a group, and is used as part of the general treatments alongside the other therapies and as a principal form of therapy. Beneficial results can be achieved, with both physical and mental symptoms and illnesses. Music therapy is suitable for children, adolescents, adults, and the elderly, and is effective with communication problems, neurological problems and problems concerning intoxicants, burnout and chronic pains. (Finnish Society for Music Therapy, 2012.)

According to the World Federation of Music Therapy (WFMT), “music therapy is the use of music and/or musical elements by a qualified music therapist with a client or group, in a process designed to facilitate and promote communication and other relevant cognitive needs. Music therapy aims to develop potentials and/or restore functions of the individual so that he or she can achieve better intra- and inter-personal integration and, consequently, a better quality life through prevention, rehabilitation or treatment”. (Wigram, Pedersen and Bonde 2002, p. 30).

Ahonen-Eerikäinen (1998) has described the four main categories of music therapy. The upper category is music therapy that is communication-oriented, which in turn is the common condition and basis for all the other main categories. The second of these is neuropsychologically oriented, the third theory-oriented, and the fourth psychodynamically oriented. Music serves different functions in music therapy. It provides a safe atmosphere, stimulates motivation and activation, and gives experiences of success. Music may serve as a means and a form of contact, as a language, i.e. as a means and a form of self-expression and as a means of reciprocal dialogue. It serves as a multisensory experience, contributes to the automatizing of working and initiates association and memory functions and stimulates verbalization. Music conditions and works on behaviour, stimulates learning, and serves as a means of working through emotions at a symbolic control oneself and contributes to the learning of controlling one's own functioning. (Ahonen-Eerikäinen 1998, vii.)

According to Ahonen-Eerikäinen (1998), the field of music therapy is too large and complex to capture briefly, since every theory of music therapy borrows something from music and from theories of therapy fields. These many kinds of theories do not offer to music therapy the one and only right model of thinking but it offers many possibilities, which are helpfully for events and encounters where the personal attributes of therapist, the music and uniqueness are have a crucial effect. Music simultaneously activates many sensory and perceptual functions. The multisensory applications and effects are important. Music achieves auditory, visual, tactical and kinaesthetically stimulation; the whole body and mind may be activated through music. This multisensory attribute of music making is the reason why it is so convenient for therapeutic use. (Ahonen-Eerikäinen, 1998.)

Listening to music may be an enjoyable way to relax, but that it has additionally found to enhance cognitive recovery and prevent negative moods (Särkämö et al. 2008). The results of the same study indicated that music, when applied during the most dynamic period of recovery from neural damage, induces long-term changes on cognition that are indexed by enhanced recovery of focused attention and verbal memory. Listening to pleasant music activates an interconnected network of subcortical and cortical brain regions, which includes the ventral striatum, nucleus accumbens, amygdala, insula, hippocampus, hypothalamus, ventral tegmental area, anterior cingulate, orbitofrontal cortex and ventral medial prefrontal cortex. The study confirmed earlier findings that listening to pleasant and relaxing music enhances the recovery of cardiovascular and respiratory functioning and decreases cortisol levels after stress. They also reported that music listening increases dopamine synthesis in the brain. This dopaminergic mesocortigolimbic system is crucial for mediating arousal, emotion, reward, motivation, memory, attention and executive functioning. (Särkämö et al., 2008.)

Molinari et al. (2005) stated that biologically speaking, rhythmic synchronization might be based more on entrainment of oscillatory neural circuits than on actual acts of measurement in terms of timekeepers. According to Molinari et al. in the presence of cerebellar damage the temporal information can be available for the motor system. The modifying motor impairments by directly influencing the motor system through the auditory system, has been possible by stroke patients.

Music therapy has shown positive effects on social and behavioural outcomes and also showed some encouraging trends with respect to mood (Nayak et al., 2000). It has also been found to be helpful in meeting meet the emotional needs of stroke patients, struggling to cope with and adjust to the situation with a sudden severe illness (Forsblom et al., 2009).

In the past two decades rhythm has been the primary focus in the investigations of the neural basis of humans. The new research insights have helped to establish a new role of music in rehabilitation. The rhythm is an irresistible, powerful tool. Music offers coordinated, attractive mutual rhythm for marching groups of soldiers and evokes their arousal and courage. The slow rhythm of march of the funeral procession leads thoughts to sorrow and makes movements slower. Music and rhythm have been used with people

working together by helping them to join forces in heavy efforts. (Sacks, O., 2008.)

Music therapy was established as a profession in the 1940s. Since early beginning music therapists have worked alongside physiotherapists and occupational therapists to support motor learning and physical rehabilitation. A comprehensive literature review by Weller and Baker (2011) surveyed 112 articles on music therapy published in English between 2000 and 2008. Fifteen of these studies were then analysed in closer detail, from the perspective of how they dealt with music therapy techniques such as auditory stimulation, active music making and movements to music. The studies were analysed according to rehabilitative aims: gross motor, fine motor and lower limb (gait). Six of the studies concerned the rehabilitation of stroke patients (Thaut et al., 2007; Jeong and Kim, 2007; Schneider et al., 2007; Luft et al., 2004; Schauer and Mauritz, 2003; Whitall et al., 2000). Schneider et al. (2007) found the active music making significantly more improving than individual occupational therapy or physiotherapy in frequency, velocity and other functional tests for twenty adult stroke survivors. Auditory stimulation was used in stroke studies in rehabilitation of gait, fine and gross motor function and was provided by metronome, drum or music adjusted to particular speeds. Music was employed to serve as an anticipatory and continuous time reference for movements in study of Thaut et al., (2007) and to increase effect of rhythmic entrainment (Kwak, 2007). Movement to music was found to assist gait rehabilitation (Schauer and Mauritz, 2003), and to increase the range of movement and flexibility (Jeong and Kim, 2007). Active music making was found to assist with fine and gross motor function (Schneider et al., 2007), and with sensimotor function (Whitall et al. 2000). The effectiveness of music therapy in physical rehabilitation was significant in improving velocity, stride length and symmetry during gate. Other significant improvements included ankle movements. Weller and Baker (2011) concluded that music therapy techniques are comparable with current treatments during gait rehabilitation and have potential to decrease duration of rehabilitation and costs in gait rehabilitation settings. They additionally suggested that music therapy techniques might benefit gross motor rehabilitation in terms of functional movement, elbow flexion and shoulder flexibility, and present a rationale for providing these methods in rehabilitation settings.

Tomaino (2009b) discusses the importance of music therapy in rehabilitation of neurological patients, and stresses the importance of self-expression. When a neurologic patient has lost his skill to move and also lost his skill to speak fluently, the quality of life

has strongly decreased. Music and rhythmic cues may bypass functional and psychological impairments of neurologic patient and effect therapeutic outcomes, like speech, communication, movements, attention, memory, learning, and emotion, and interpersonal relationships. Patients with stroke or some else neurologic diseases often have problems with gait, balance and coordination. Rhythm may be used as an auditory cue to structure time and stimulate effective the synchronization of physical functions, and creates a time-ordered pattern to which the patient coordinates his movements. Music or rhythm may have an activating influence to the neurologic patient, so that the patient does not need as much self-initiation to movements. For most of neurological patients the initiation is the problem by movements. The therapist, Tomaino suggests, may help in coaxing the movements with music or rhythm as a stimulus. (Tomaino, 2009b.)

For people with neurological problems it is not fear that keeps them from motor initiation or coordination but rather the inhibition of a neural system. They cannot “think” about how they execute that movement or skill. Providing rhythm to supplement a sense of movement through the modulation of tempi enables the person to follow rather than to initiate. The slight change in orientation, i.e., following rather than initiating, enables for the function to be attained. (Tomaino 2009b, p. 215)

Weller and Baker (2011) note the broad consensus in the literature of the effectiveness of using music in the rehabilitation of patients with impairments to cortical function and long-term memory. Their literature review also found broad agreement that it contributes to emotional stability, relaxation, increased attentiveness, motivation, enjoyment and providing and physical rehabilitation outcome, decreasing perceived exertion, offering structure and distraction from pain. Based on their review, Weller and Baker propose that music has shared parallels between neural processing systems and non-musical functions, including stimulation of premotor neural activity required for motor learning and motor memory. They additionally hypothesize that music is employed to connect the physiological, psychological and emotional components of music therapy within the physical rehabilitation setting.

## **2.4 Functionally oriented music therapy and the brain**

Cognitive music therapy applies to modify the establishments of brain activity and improve the neurocognitive ability. Äystö (2005) examined the organisation of musically skills to the

neurocognitive capacity of intellectually disabled persons. Neurocognitive music therapy, based on the method of Figure notes, applies to contribute the integration of musical essentially establishment of functional classification and the adaptation to musical environment of an individual. In music therapy has been established rhythm, voice and melody to underlay on intelligence. The elements of music therapy have been expounded to be in relations to cognitions. Äystö reported remarkable results relating to improved perception and processing of rhythm, and found a positive correlation between rhythm and speed of speech. When an individual is able to read the figure notation, he simultaneously improves the functions of the primary, secondary and tertiary areas of the brain. (Äystö, 2005.)

The target-oriented training based on rhythm is suitable to improve neuropsychological rehabilitation and neural education. Music therapy is neurocognitive oriented when imitation of rhythmically and consecutive cues are compounded with therapy, which takes into consideration the neuropsychological difficulties (apraxia, motor performance, crossing the middle line etc.) of an individual. The neurocognitive orientated music therapy using the combination of verbal elements (rhymes, song lyrics) to the motor performance, is able to develop person's working memory. (Äystö, 2005.)

Functionally oriented music therapy is a communication-based and neuropsychologically-based method that was originally developed by Swedish therapist Lars Hjelm. Usually the method is practiced with individuals without using verbal communication and guidance. In the method the patient is induced to activate his, her motor body control, coordination, hand and eye cooperation, and rhythmicity while the patient is concentrating in the playing with drums accompanied by the piano playing of the therapist. The method aims to develop patient's conception of his or her bodily capacity in relationship with environment, realization of distances of objects, drums. By playing drums rhythmically accompanied by the piano music, is developing patient's ability to regulate the power of muscles, the velocity of movements. Functionally oriented music therapy applies to create atmosphere of concentration instead of suspense, applies to increase endurance for motor exercises, and permits the motor performance to arise with slight efforts, producing positive mood for the patient. The method is used as therapy for patients with learning difficulties, disturbances of attention, and autism. The method is additionally widely used with stroke patients and with persons with dementia. (Kettunen, 2010.)

Ahonen (2000) notes that the brain has divided functions in music production and music perception. The left side observes the shape of music and rhythmical structures of music, whereas the right side follows the quality of the music and the emotions conveyed through it. Singing without words, humming and the harmonic of music is perceived in the right half of brain. The rhythm, words and the harmonic structures are perceived in the left half of brain. Ahonen remarks the importance of therapeutically use of music throughout the neural connection between the left and right side of cerebrum. Music may be used as a remarkable resource of self-expression. (Ahonen, 2000.)

Systematic use of music may improve brain plasticity. Music and language processing both are involving bilateral hemispheric activities in the brain. The pitch of music and speech prosody is processed in the right temporal lobe. There are elements of singing in speech and elements of speaking in singing. The systems may complementary each other when one of them is impaired. (Tomaino, 2009b.)

## **2.5           Speech rehabilitation with rhythm and music**

Intonation has an important role in conveying the mood, emotions, thoughts and experiences of the speaker. The social isolation may be a threat for the stroke patients with intonation impairments. They may be at risk of being misunderstood and avoiding conversations with people. Music has proved to affect mood, which influences to relaxation of vocal fold. The unstressed muscles in voice apparatus are able to use intonation and dynamics in the voice. (Baker, Wigram and Gold, 2005.)

Music, singing and rhythm have proved to help by the speaking problems of the stroke patients. According to Thompson (2009), there was evidence by the end of the 20<sup>th</sup> century that music processing diverges from speech processing and is handled in the right hemisphere. It was accepted as the hemispheric dominance and lateralization, like Broca's specialized area for language production and Wernicke's area for speech perception in the left hemisphere. The left hemisphere is implicated in many aspects of music including language-like skills, like naming notes and pieces. Peoples who have cerebrovascular accident, a stroke in their left hemisphere, may have difficulties with speech. (Thompson, W., 2009.)

The Sipari® method is used in Germany on speech therapy for patient with Brocha's aphasia. The treatment aims to support phonological and segmental capabilities of the left hemisphere of brain. In the method the human voice is the primary instrument employed, accompanied by rhythm instruments. (Jungblut, 2009.) The name comes from the essential elements of the method: S= Singing, I= Intonation, P= Prosody, A= breathing (*Atmung* in German), R= Rhythm and I= Improvisation. The method promotes impaired sequencing with rhythm, changes in tempo, and rhythmic alternations (instrumental/vocal turn-taking) (Jungblut et al., 2009). Singing provides a therapeutic tool for ameliorating the speech. Singing engages an auditory-motor feedback loop in the brain more intensively than other music making activities such as instrumental playing. Melodic Intonation Therapy (MIT) is emphasising the prosody of speech trough the use of slow, pitch vocalization or singing in combination with rhythmic tapping of the left hand. The use of hand tapping or external auditory cues has been demonstrated to facilitate vocal output. (Wan et al., 2009.)

Melodic Intonation Therapy (MIT) has been found to be effective with Brocha's aphasia patients. While a person is speaking the left hemisphere of brain is in action, while singing with words that use either the right or both hemispheres. The bihemispheric role in the execution and sensimotor control of vocal production for both speaking and singing is supported in a small amount of empirical data. Schlaug et al. (2008) have identified the possible mechanisms by which the facilitating mechanism of MIT may be succeeded: reduction of speech, syllable lengthening with speed of singing may receive support from right-hemisphere structures, like also syllable "chunking". The use of left hand tapping with syllables provides an impulse for verbal production in other motor activities, like "pacemaker". They suggest, that there may be set of shared neural correlates that control both hand movements and articulatory movements. In the article of Schlaug reported from the fMRI studies, which have revealed motor and linguistic cortical representations of objects being closely linked. The premotor cortex may belong to an integrative network coordinating motor and linguistic expression. (Schlaug et al., 2008.)

In my work with cerebellar stroke survivors I have found similarly positive effects through tapping while speaking to the patient. According to Tomaino, dysarthria, a motor speech impediment that is commonly suffered by stroke patients, produces problems with

coordinating respiration and articulation. The use of rhythmic cuing to reinforce the words in phrases can be a strong therapeutic tool for improvement in speaking. (Tomaino, 2009a.)

The inclusion of music in rehabilitation has been evaluated by Kleinstauber and Gurr (2006). In relation to speech they mentioned that human musical abilities are important for the acquisition and processing of language, like word boundaries through different types of prosodic cues. The human brain treats language as a special case of music. Kleinstauber and Gurr found that creative therapies, like music therapy should become more acknowledged as vital parts of rehabilitation programmes of brain-injured patients, and that music can be creatively adapted to range of therapies such as neuropsychology, occupational therapy, speech therapy or physiotherapy. Chan et al. (1998) found that adults with music training learned significantly more words than those without any music training. Their results provide preliminary evidence that music training may have a long-term effect on the improvement of verbal memory.

## **2.6 Rhythm, movement, coordination and control**

Rhythm is the primary property of music and rhythmicity is in human life in many ways. Our natural and spontaneous body movements may be outward representations of inner timing. At five months of age, when a fetus's neural circuits and auditory memory are forming, it experiences rhythm through the mother's heartbeat and respiration. Immediately after birth, basic motor patterns begin to develop. While eating, crawling, and walking, each child finds a cadence, particular motor rhythms that will remain fairly consistent throughout life. (Tomaino, 2009b.)

Juntunen (2004) describes the Dalcroze Eurythmics approach to music education, which is based on the ideas of Émile Jaques-Dalcroze and aimed at developing musicianship in a broad sense. Jaques-Dalcroze depicted the sense of rhythm as the capacity to feel or "sense" the time between movements, and as connected to the ability to control the variations of the elements of time, space, and energy in movement. Jaques-Dalcroze defined rhythm as having its origin in natural body movements and thus being physical in nature. Accordingly, he suggested that it is most natural to develop the sense of rhythm through movement (cited in Juntunen, 2004).

Kukkonen and Piirainen (1990, 11-15) emphasized the close physical interaction between a person and his or her environment. Posture, movements, and speech provide signals of one's inner life, and provide a foundation for human motor behaviour. They consider the meaning of movements with a thought of rhythm. Movements are thought to involve change and movements are achieving change and the world is realized in the change between the two restful states. This cycle of activity-rest manifests among nervous system and muscle functions. The cycle of activity and rest also manifests itself in rhythmical cycles of breathing, digestion and other physiological functions. Movements are connected in bodily and consciously actions, and in this way become meaningful.

A human being is expressing himself in speech, posture and movements. Also speech involves movements. The form of movement and the rhythm are indicators of internal order and conceptualization of the world. The postures and movements are often revealing also such things a person is not willing or capable to express. Body language is more primitive and true as the spoken language. One's movements and posture are mostly created by the experiences of emotion and by the will. The movement are stating in the cycle of particular time and particular space. It demands particular amount of force and it shapes in particular form. The movement occurs here and now. Its duration is always restricted. For these factors the time and rhythm are meaningful in considering the concept of the movement. (Kukkonen and Piirainen 1990, pp. 19-20.)

Jaques-Dalcroze believed that rhythmic movement exercises would help the young people to think and express themselves rhythmically. For Jaques-Dalcroze the sense of rhythm means the capacity to feel or 'sense' the time between movements, and is connected to the ability to control the variations of the elements of time, space, and energy in movement. The sense of rhythm is manifested in rhythmic movements, which in turn affect the rhythmic expression of musical performance. According to Jaques-Dalcroze, "All who are badly organized rhythmically are awkward and clumsy in bodily gesture and movement even if the ear is musical", (quoted in Juntunen 2004, p. 27).

According to Sandström and Ahonen (2011) the regulation of coordination is called the activity enabling the appropriate cooperating of muscles. Neural activations are establishing coherent functioning groups of muscles, which are becoming active together

and are constructing a synergy. Coordination is a process facilitating motor performance, when two effectors, like upper limbs are moving synchronic, spatial coherently. The upper or lower limbs are coordinated to function together cyclic, like walking, running, swimming. The limbs are striving to move in-phase (the relative phase of movement is 0°) or anti-phase (the relative phase of movement is 180°), coordinated in the ratio 1:1. Coherent, in-phase working, or incoherent, anti-phase working depends on a particular combination and plane of movement of the limbs. If movements towards the body or away from the body are involved, the patterns produced are described as being egocentric. Allocentric patterns are movements directing towards space surrounding the body.

Two-limb cyclic movements on the horizontal plane produce either mirroring symmetry or parallel coordination. In the former, symmetrical muscle groups function simultaneously in both limbs with a relative phase of 0°; in the latter, symmetrical muscle groups functioning in turns, with a relative phase of 180°. The coherent, cyclical two-limb movements are more stable and demanding less attention than the incoherent movements. There is an egocentric limitation in a case, that movements have different relative phases. Inspecting the simultaneous movements of upper and lower limb, there is noticed, that the movement is more stable and easy, if the pair of limbs is anti-homologic (e.g. left arm and right leg) and moving in the same direction (relative phase 0°). There is an allocentric limitation if the anti-homologic limbs are moving in different directions (relative phase 180°). (Sandström and Ahonen, 2011.)

The cerebellum contains half of all the neurons located in the brain, yet constitutes only 10 % of brain weight. The role of the cerebellum in motor control is awesome, ranging from a comparator role to involvement in motor learning. According to Newton (2002, pp. 67-71), the cerebellum assists other higher centres to coordinate motor behaviour and is involved with planning and executing movement, as well as serving a comparator and corrector role. A well functioning cerebellum occurs smooth coordinated movements. Cerebellum regulates force, range, and direction of movement. In addition to the roles played by the cerebellum in assisting other higher centres to coordinate motor behaviour, the cerebellum also regulates some autonomic functions including pupillary size, respiration, and cardiovascular functions.

Newton (2002) made the following generalizations about neuroanatomical connections and the role of cerebellar areas in motor control. First, input to the archicerebellum area signals changes in head position and orientation of the head in space. Output from this area regulates axial muscles used to maintain balance and controls eye movement for coordination of eye-head movement. Second, the spinocerebellum (paleocerebellum) receives sensory information from the periphery through the spinocerebellar tracks and from the visual, auditory, and vestibular systems. Output from the spinocerebellum regulates axial and proximal musculature. Damage to the spinocerebellum results in abnormal muscle contractions. Agonistic muscle activity is prolonged, and timing of antagonist contraction for limb deceleration is delayed. When deceleration and stop commands are disrupted, movements become inaccurate and tremor occurs, particularly at the end of movement. Third, the cerebrocerebellum (neocerebellum) receives input from the cortical, premotor, motor, sensory, and posterior parietal lobes of the cerebral cortex. Output from this area includes a decrease in control of distal extremity musculature. Another possible role for the cerebrocerebellum is programming of movement, the decision to move, the initiation of movement, or the coordination of eye-hand movements for manipulation and exploring the environment. (Newton 2002, pp. 67-71.)

## 2.7 Learning movements related to memory

Memory is a recorded change of function attributes of neural networks based on learning. Learning could not occur without the function of memory. Learning means permanent change in behaviour, knowledge, understanding, point of views and skills, which are not explained to arise of physical growth or development. Memories that are tied to a particular place and time are known as episodic memories, and those that lack such an association, are known as semantic memories. Explicit memory has stored facts, events and experiences, knowledge recallable and verbal explainable. (Underwood, 2012.)

Neural motor time indicates to timing of behaviour in movements, production of speech and cognitive actions. Neural time regulates the duration of movement, rhythm and synchronization of movements. The working memory is not needed in automatically executed events of 1.7 – 0.45 seconds duration. Attention and working memory are needed for events lasting between 1.8 and 3.6 seconds. Memory may additionally be

connected in conceptualization of human life. Episodic memory rests on self-awareness and autobiographical memories, whereas semantic episodic memory contents fact connected with the past, awareness of own identity and knowledge, where a person is born. The conceptualization of time may be structured in various ways and by various anatomical structures. For instance, circadian rhythm is coordinated by the suprasciamatrical ganglia of the hypothalamus, whereas timing of intervals (from seconds to minutes) occurs in the striatum, prefrontal cortex, lobes parietal, SMA. Timing of even shorter periods occurs in the striatum, cerebellum, prefrontal cortex, SMA, and anterior cingulate gyrus. (Sandström and Ahonen 2011, p. 43.)

Motoric memory is part of the implicit, non-declarative memory, and includes acquisition of motor skills, application of learned skills and motor adaptation. Motor skill learning may also mean the appearing of new models of coordination. (Sandström and Ahonen, 2011.) In motor skills there are four main memory-related factors that affect motor skills. These are the starting situation; parameters such as timing and the order of movements; the ending point (external feedback); and sensory acquaintance, such as how the movement was visualized, how it sounded or felt. By extending the level of motor skills is the permanency of memory traces also extending. This phenomenon is called consolidation and is part of implicit memory. Verbal feedback aids in cognitive processing of the task, leading to more conscious learning. (Sandström and Ahonen 2011, p. 66.)

According to Tomaino (2009), skills are also memories. Many of these functions are rhythmic in nature and they may be stimulated through rhythmic signals. Music or rhythm may have an activating influence to the neurologic patient, so that the patient does not need as much self-initiation to movements.

In motor learning there is formation and refinement of internal models in dynamic nervous network. The premotor cortex is choosing the muscle synergies and learns to control the grades of freedom in joints. Repeating muscle synergies is increasing the mount of muscle presenters on the motor cortex and achieving synaptic modification of learning. Particularly important for motor learning is the sensory feedback of movement, like from proprioceptors, tactical receptors, visual and auditory feedback. Neural activation is changing by learning a repeated familiar movement and also by acquiring new sensor-motoric links. The motor skills learning process requires sufficiently time to rest. To sleep

in the night is a way to expand the learning skills process in the consolidation phase, and a daytime nap also helps stabilize motor memory. (Sandström and Ahonen, 2011.)

## 2.8 Motor performance and sensory activation

Autio (1995) discusses motional competence and overall definitions concerning movements in the context of the typical child's range of movements. Adults who have lost some or all of their ability to move smoothly (because of stroke, accident etc.) are forced to relearn gait and movement, as with a child. The child learns to resist gravitation and is able to go through combinations of difficult movements. Autio describes rhythmical movements as including regularity and preparation: the sense of rhythm is a developing attribute and an important part of locomotion. By repeating basic movements it is possible to evolve more economical, appropriate, and harmonic movements. The use of power will be applied correctly and task will therefore become easier to carry out. Repetitive movements will increase in accuracy, confidence, and velocity. Repetition eventually leads to complete control of movements, to automaticity, and to a lessening of the amount of voluntariness needed to execute the movement.

Motor learning is a feature of human competence. Motor skill is acquired when movements are coordinated and controlled in such a way that personal motor goals are fluent, faultless, and automatically achieved. Motor learning has been divided in five phases: an early rapid phase; a later, slower phase during which the level of performance improves; a consolidation phase, when the level of skill improves in rest without extra training; an automation phase; and a retention phase. (Clark and Ivry, 2010.) Motor behaviour research suggests that the transfer in motor learning between tasks trained appears to be dependent on similarity of tasks (Vansant 2002).

In rehabilitation of stroke patients the instructions for motor learning are significant to choose by therapist. Patients with cerebellar stroke profit from explicit instructions improving implicit learning in contrast to usually stroke patients, by whom the explicit instructions are impairing implicit motor learning. (Shumway-Cook and Woollacott 2012, p. 137.) The attainment of new motor skills gives a person greater trust in his or her own abilities, giving them more pleasure from movement. Consequently, increased self-esteem aids the motivation to continue learning. (Simola-Isaksson et al., 1982.)

The neurosciences have large benefits to offer, for example for physical education. Research has already found explanations for the value of those musical, rhythmical games that are universal to children throughout the world. The huge development of computer games, the virtual world tempts children and adolescents to spend time sitting affront of monitors. Fortunately there are additionally hobbies raised upon adolescents activating them to move and enjoy the rhythmical movements. Breakdance, for instance, offers a very multifaceted experience of moving to the beat. Such movements are highly difficult to perform without auditory stimulation, without strongly rhythmical music in the background.

The auditory system, a fast and precise processor of temporal information, projects into motor structures in the brain and thereby creates entrainment between the rhythmic signal and the motor response. Rhythmic Auditory Stimulation (RAS) is widely used in Japan for stroke patients, as it has been shown to be beneficial with those who have suffered lesions in the putamen, cerebellum and thalamus. The positive influence of rhythm is explained with connections between sensorial and motor areas, the audio-motor pathways in the brain. Significant changes in the total pattern of gait movement suggest that RAS also influences and improves positional and muscular control. (Thaut and Abiru, 2010.) Rhythmic auditory stimulation uses multiple auditory-motor pathways to access and entrain central motor processors that respond and couple to rhythmic time information to stabilize motor control independent of specific neuropathologies. Results have shown that music-supported therapy had a positive influence in fine as well as gross motor skills with respect to speed, to quality of movements. The effectiveness of standard physiotherapeutic approaches in stroke rehabilitation has been found to be quite limited, thus calling for innovative motor rehabilitation approaches. (Thaut and Abiru, 2010.)

Rhythmic auditory Stimulation (RAS) is widely used as a method for enhance quality of walking, gait by stroke patients and patients with Parkinson's disease. Abiru et al. (2010) reported the beneficial effects of RAS on gait training by patients with cerebellar ataxia after a stroke. In a pilot study conducted in South Korea, Jeong and Kim (2007) found the combination of rhythmic music and rehabilitation movements to be effective, with participants gaining a wider range of motion and flexibility, and experiencing more positive moods and more active social lives than control participants in the study.

The effectiveness of standard physiotherapeutic approaches in stroke rehabilitation has been found to be quite limited, thus calling for innovative motor rehabilitation approaches. Melody and rhythm may help to shape the quality of the movements of the disabled limb. Audiomotor coupling acts as a powerful mechanism for shaping motor activities. Music making, even in musically unskilled patients, might be an effective way to induce plasticity changes in the motor system. Music could in addition shape movements through the immediate auditory feedback. (Altenmüller et al., 2009.) By concentrating on external focus the individual takes advantage of the motor system's automatic control capabilities – with the result that performance and learning is enhanced. In contrast, focusing on one's own movements results in a relatively conscious type of control, which tends to constrain the motor system and disrupt automatic control processes; this is the so-called constrained action hypothesis. (Wulf and Mornell, 2009.)

Music making, even in unskilled patients, might be an effective means to induce plastic changes in the motor system. Music could in addition shape movements through the immediate auditory feedback. (Thaut and Abiru, 2010.) The speech of the therapist, the verbal guidance may although have a disturbing influence to the motor performances of a neurological patient with cognitive impairments. Talvitie and Reunanen (2002) took an interesting perspective on the physiotherapist's way of guiding the performances and exercises of stroke patients. They analysed filmed footage of physiotherapy sessions and examined patient-therapist communication, and described the interactions as being like the former give verbal orders assisted by manual cues and the latter respond by performing physical acts. The therapeutic atmosphere was in sessions mostly calm and secure. The physiotherapists responded to the patients' comments mostly by showing sympathy and encouraging them to continue the training. Oral guidance in the sessions included guiding patients' movements before practicing them. In this way the physiotherapists modelled the right action and mostly justified their instructions with reasoning. Modelling of the starting posture took a lot of time and often the exercise proper consisted of only a few repetitions. Talvitie and Reunanen were surprised at the mount of oral guidance given by the therapist in the interactions. The contents of the therapist's speech often seemed too complicated, and created misunderstandings with patients with speech difficulties. (Talvitie and Renames, 2002.)

Schneider et al. (2007) studied tactile and auditory stimulation in the context of active music-making, and tried to enhance the fine and gross motor functions of twenty stroke patients. In finger tapping and hand tapping exercises significant improvements were seen in comparison with the control group, as the music helped in integrating the auditory and visual senses. This multimodal stimulation may help the patient to attend to stimuli, increase motivation for frequent repetitions of identical movements. Music making provides a possibility for cognitive, emotional and social functioning with physical rehabilitation.

Multisensory activation is helpful in activating motor performance, but this does not show a lasting effect on learning. According to Wulf and Mornell (2009), who have studied the perspective of motor learning by musicians, as long as the teacher guides the instrumentalist through concurrent feedback (singing along, counting out loud, clapping, conducting in the student's field of vision), the student stays in rhythm. This "success" is however just a short-term performance effect, and not a sign of learning. Specifically requiring learners to estimate their errors after the completion of a movement has been shown to enhance learning even further. (Wulf and Mornell, 2009.)

In recent years there has been some success in explaining why imitation is such an effective aid in learning motor skills. Children in particular learn most of their motor skills in this way. Mirror neurons are significant in learning here, since the visual stimuli in lobus occipitales activate areas in the sulcus temporalis superior (STS), the lower part of lobus parietalis, the Broca area and the premotor cortex. With the help of the mirror neurons system a human being may understand the motor intentions of another human being, like it often occurs in social interactions. The area of mirror neurons, the Broca area is important in understanding of motor actions. The mirror neurons are motor neurons, which are reacting, when a person is motor activated or when a person is watching movements of somebody else. The person, who is observing one other person, will have the same activation in his motor neural network as the moving person has in his activated motor areas. Mirror neurons have visual-motor and/or audio-motor attributes. (Hari, 2006.)

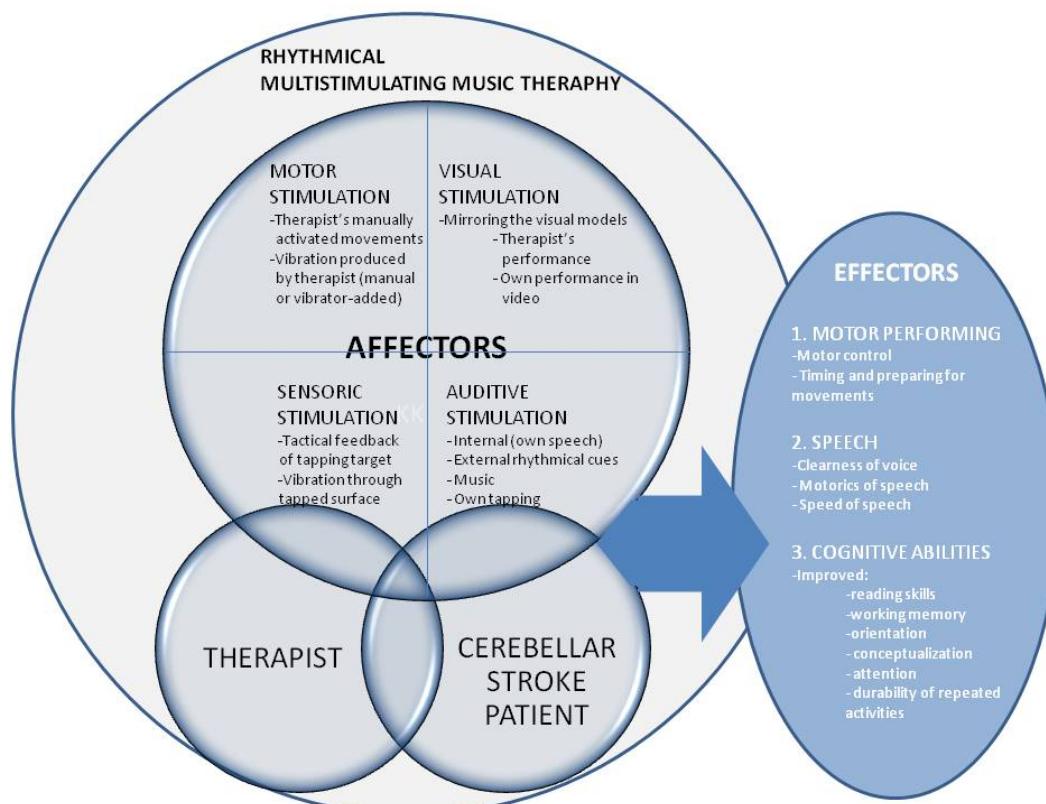
Mirror therapy is a method of activating the distal arm functions of stroke patients. The patient is observing the healthy arm moving believing that the arm, which moves, is the paralyzed one. The patient sees only in the mirror the healthy arms movements. The distal functions of the arms improved more with mirror therapy. Furthermore, mirror therapy

enhanced recovery of surface sensibility and stimulated recovery from hemi-neglect. Neither of these effects depended on the side of the damaged hemisphere. It has recently been suggested that mental practice might also be of interest for reducing stroke-induced motor speech disorders. Combined motor and mental training probably improves motor flexibility via connections from both motor and cognitive systems to the cerebellum. (Johansson, 2008.)

A neurological patient with motoric impairments must face the fact that he or she has to learn the lost skills again. Healthy children learn by watching others, but this may not be enough by neurological patient, who may first have to create a mental picture of the motor task. The therapist may help to create the movements by moving manual the limbs of the patient, to let the patient feel the movements. Vibration (quick repeated movements) increases the knowledge of muscles of patient. Vibration may be produced manually by the therapist or with a vibrating device. The motor program is comprised of motor primitives, synergies, like central pattern generators regulating rhythmical movements. (Sandström and Ahonen 2011, pp. 66-68.)

## 2.9 The theoretical framework

I have made the conceptualization of the theoretical framework for rhythmical multi-stimulating music therapy based on the literature review and on my clinical experiences as a physiotherapist. The phenomenon rhythmical multi-stimulating music therapy in Picture 1 by the largest circle incorporating the three blue circles. The stimulating activations are induced either by the patient or by therapist, or by they both together are effecting and increasing the quality of motor performing, speech, and other cognitive abilities.



Picture 1: The Framework for rhythmical multi-stimulating music therapy

### **3 RESEARCH METHODOLOGY**

This thesis is a descriptive case study of the music therapy process that I as a professional physiotherapist have used, employing multisensory activation, music, music perception, music making and rhythm with a patient who has had seven cerebellar strokes. The rehabilitation process described in the study was conducted as my clinical music therapy training during my basic studies of music therapy, one year before beginning the Master's Program at the University of Jyväskylä. The uniqueness of problems with the cerebellar stroke patient motivated me to search for new ways of applying music therapy to these problems. I became aware of the effectiveness of music therapeutically methods in the physical rehabilitation for the patient impaired by several strokes in cerebellum. This study aims to identify in the experiences some relevant issues for the rehabilitation processes of cerebellar patients to work with. By analysing the content of the process and the tasks used, the study:

- 1) examines how the rhythmical multisensory activated tasks affect the relearning of motor control for movement and speech;
- 2) identifies, describes, and evaluates some of the enabling and hindering elements of tasks used in the therapy sessions, and highlights some relevant issues to work with later in the rehabilitation process;
- 3) gives the researcher a deeper understanding of the role of music and rhythmical exercises in relearning movements and fluent speech.
- 4) assesses the success of the methods used in rehabilitating the patient.

This chapter explores the resources that the ordinary physiotherapist is able to find for intensifying the physiotherapy treatment by using easy, simple exercises with rhythm, music, tapping, and speech combined to movement exercises.

#### **3.1 Methodology**

Approaches to rehabilitation may vary according to the therapist views concerning the disciplines and insights of a human being. In this particular study, the patient is considered as a "whole person", that is, by simultaneously taking into account psychological,

physiological, and sociological aspects relating to his rehabilitation. The study is informed by some ideas from phenomenological and hermeneutical research, drawing on Tuomi and Sarajärvi (2009).

According to Wigram et al. (2002), qualitative research takes a broad view and focus, studying and interpreting human behaviour as a main part of the process. In the present context, qualitative methods are used to explore processes by discussing why the music therapy is effective, how does music therapy work and what is happening within the client-therapist relationship. Wigram et al. find it important to find which components or elements are within the interventions that make it effective:

What's the point of producing a study which shows that an intervention is effective, if you cannot explain how to administer the intervention, or what components or elements there are within the intervention that cause it to be effective? It is like administering a medication without listing the chemical properties of the pills involved. Both qualitative and quantitative research frequently involve observing, analysing, evaluating and interpreting human behaviour, and both approaches are interested in the way music therapy functions as a treatment. (Wigram et al. 2002, 224-225.)

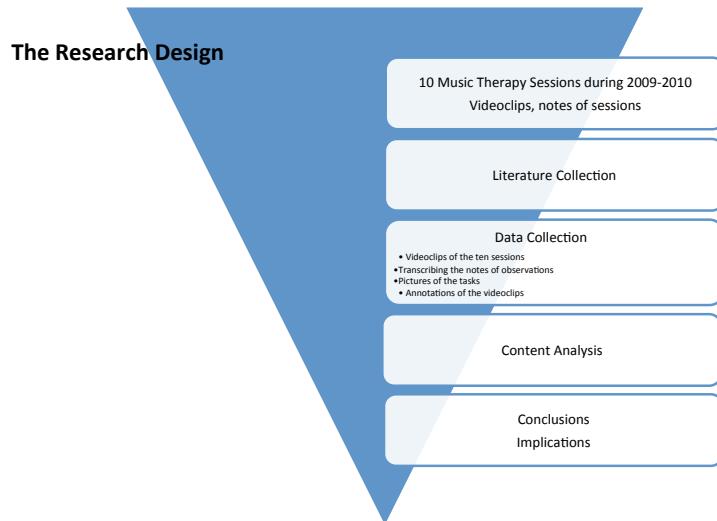
Qualitative data may aid in highlighting issues and critical points that demand more material for an adequate explanation of the matter at hand. The researcher must then extend his or her knowledge of the issue in order to be able to understand and conceptualize the problem. (Aaltoila-Valli 2001, p. 72.) In qualitative research the literature upon the issue searched is possible to expand after starting the trial. The trial may be the starting point, when the theme is slightly known. The theoretical knowledge will be gathered later for to explain the phenomenon (Tuomi and Sarajärvi, 2009, p.156). In the view of Hirsjärvi et al. (2001, p.152), qualitative research typically aims to reveal and describe realities and phenomena in a comprehensible manner, whereas quantitative research is based on the idea of verifying theories already existing.

The case reports with the information presented in them may be used directly to change practice, to revise theories, and to suggest areas for future research. The information gleaned from case reports can contribute directly or indirectly to changes in practice. Case reports could be seen as communications from practitioners to scientists. The case report is valuable by sharing clinical experiences, by developing hypotheses for research and contributing to practice presenting frameworks for problem solving by clinicians. Case

reports may help practitioners to deal with change, influence administrators, and persuade physicians and insurers of the value of services for particular patients. Case reports may help develop practice guidelines and pathways. (Domholdt, 2005.)

The large field of music therapy became open to me during my basic studies in music therapy at the Open University of Jyväskylä. My experience as a physiotherapist guided my interest to find new elements for use in my rehabilitative work with neurological patients. The patient discussed in the present study, Jussi, has complicated problems involving inexact movements and impaired, uncoordinated motor functions, and non-fluent speech needed new advices and approaches to be adopted. With this in mind, I wanted to concentrate in my studies on the rehabilitation of cerebellar stroke survivors. The study is based on the notes, the written report and video clips recorded during ten music therapy sessions undertaken with the patient in 2009 and 2010.

The study aims to describe and identify a rather new and complex phenomenon in the field of rehabilitation by combining tools of music therapy to physiotherapy context. In order to meet the objectives of the study, the empirical research was designed as follows, and is visualized in the Picture 2. The first step was a written description of the case study and the progress of the ten music therapy sessions with the cerebellar stroke patient. The theme locked me to read more literature about movements, motor control, and about the ways of teaching and learning movements. The literature review is figured as the second step. As third step was to choose and transcribe selections of the filmed sessions (were chosen and transcribed) and to create visual models of the rhythmical tasks conducted with the patient. A content analysis of the process was then conducted, and this included descriptions, analyses and evaluations of the therapy tasks. As a last step, based on this analysis the main advantages of multisensory activation tools and their applications in therapy were considered, and some new ideas and aspects that arose from the process were identified and explored further. In addition, the study evaluated some of the enabling and hindering elements of the tasks used in the sessions.



**Picture 2: The overall research structure**

The literature for the written report of the ten sessions in the basic studies 2009-2010 appeared too restricted. I started the process of Master's thesis by acquainting myself with the literature concerning strokes, rehabilitation, cerebellum, music therapy, relearning movements, memory, and neurophysiology. I was searching additional material of strokes with a mention of the cerebellum. I was not entirely successful, however: I found lot of research on strokes, but fairly little specifically on cerebellar strokes. I found this problematic in view of the important role of cerebellum in timekeeping and in relearning movement. The current interest in cerebellum impairments may direct towards affections or injuries in the cerebellum. I felt that there was a real gap in the knowledge of rehabilitation of cerebellum patient, particular with the music therapy of a cerebellar stroke patient.

### 3.2 Specifying the rhythmical exercises

The therapist did not have any strict plan or rules in the music therapy during the basic studies of music therapy. I had an idea on how to proceed, but did not want to exclude the possibility of improvising where this seemed appropriate and beneficial to the patient. Using my experience as a physiotherapist and my studies in music therapy as a basis for

clinical training, I aimed to inspect the tasks with the idea of finding some relevant differences in the structures of the tasks, some difficultness domains in them.

I divided the tasks regarding the directions of movements of hands, the targets to tap, amount of hits on the drums, and rhythms with a 3/4 or 4/4 beat. The tapping tasks were divided based on the amount of targets (1-4) to tap in each task and analysed them according to the particular difficulty involved in each tapping task (tasks 1, 3-13, 20). The numbers of tasks were written on a vertical scale, and were defined based on the continuity or discontinuity of the two patterns contained in them. The tasks were arranged in estimated order of difficulty, from the easiest to the most difficult (from left to right, respectively). The easiest task involved just one target, with the most difficult involving four targets. The patterns were assigned the following colour code judged to involve some complexity:

- Hands crossing the middle line = green cross
- Challenging choreography of hand movements = blue square
- Different timing, duration of taps = violet circle
- Amount of hits on each target = red triangle

A table of the issues observed in every task (including the tasks described in the notes and those on the videos) was drawn up. The tasks were arranged vertically in the order they were used in each session. The tasks in the horizontal row had the following criteria:

- Regularity of tapping
- Proper number of taps
- The patient must speak while working
- Clarity of the patient's voice
- The patient's mood while working
- Amount of repeats required until the task succeeded
- Observations of coordination, power used in the task
- Accompaniment (from a CD or from the therapist reciting or singing)
- Observations of the difficulties

Based on the categorizing table I attempted to gain a better understanding of the influences on the relative difficulty or fluency of the tasks. There were 104 task analyses in all. The warmup tasks were not graded by level of difficulty, and were explained separately to the patient. The various task domains were planned based on the patient's own specific areas of difficulty. Because of limited amount of data domains, I saw no need to use statistical tests to compare the domains.

The patient discussed in this study suffered six strokes in his cerebellum on the right and one stroke on the left side in spring 2008. In that time he was 54 years old, working in a janitorial service company. He was living in own house together with his wife. He was staying one month in the hospital in the neurological department. The patient was assigned to me at the physiotherapy Clinic OMT Fysioterapia Manukatti Oy. At first he attended twice a week for 45-minute sessions, which was later reduced to once a week. The patient paid for the therapy himself.

Over the course of fifteen months of music physiotherapy, the patient's physical abilities improved noticeably. He learned to ride a bicycle again, and during the summertime was cycling 20-30 kilometers a day. He began swimming again regularly and going to the gym once a week. But he had problems in many areas, and he explained that he had felt that his physical identity changed after his illness. He had noticed that his gait differs from that of other men, and that he had several physical limitations. The illness, he told me, had caused him an enormous amount of worry and loss of self-identity and control over his life. One of the patient's most important goals was to become once again more like other people — to be able to walk, jump, and ski like other people, and to be able to speak more clearly and to read more fluently. In addition, he had noticed his difficulties with memory and concentration.

The patient's strengths included an enormous motivation for getting well, and a good sense of humour. He was plucky, not at all shy, and able to look after himself independently. His motor impairments included the need to face the direction in which he was moving; if he turned his head while walking, the rhythm of his walking became interrupted and he then tended to stumble. He walked with wide steps, with his body flexed forwards at the hips. His arms did not move freely, and his shoulders were tense as he walked. The thorax was not turning with the steps and arms. The range of movements

in ankles was limited. The balance on standing on high toes was unsure. While concentrating in motor tasks, the patient moved his face and mouth (associative movements), and tension in the right arm increased simultaneously. The activation of the closed kinetic chain remained incomplete. The transversus abdominis muscle did not activate itself, which affected his gait. The patient had also difficulties in activation of gluteal muscles. Movements crossing the middle line were uncoordinated, like stepping cross. He had difficulties in multitasking; he could not walk or do some movement exercises and talk simultaneously. His right hand and arm did not move with any precision and the line of movement was hesitant. The patient said that he felt that somehow his right eye was disturbing him, and that he had some indefinable feeling in that eye. He also suffered from dysarthria, which caused difficulties in pronouncing certain combinations of letters, like dr, dj, pr, tr, and the vowels yö and äy that are characteristic of Finnish. He often needed to clear his throat while speaking. He could read slowly in the beginning of the music therapy sessions. In Finland films and programs in languages other than Finnish are subtitled in Finnish, but the patient's reading was so slow that he could not keep up with running texts.

His writing was legible, but was skewed and had a tendency to become smaller as wrote. The patient was eager to start a task given by the therapist before therapist ended speaking. He did not have a completely clear understanding of what to do, but still wanted to start. The therapist had to give very simple and short orders for the tasks, with no more than one per sentence. When a task was completed and the therapist gave new orders, it often happened that the patient continued working in accordance with the instructions for the previous task: he heard orders, but either forgot them quickly or was unable to adopt the new way of working required for the new task.

The goals of the ten music therapy clinical training sessions with the patient included achieving more symmetrical and fluent use of the body, improved coordination in movements and speech, and increased self-esteem based on successful training. The general focus in the sessions was to find the optimal coordination and timing of the movements with the help of tasks described later in the study. Both therapist and patient were keen to discover if the patient could benefit from simultaneous combinations of movement, speech, and rhythm. As the sessions proceeded the patient became increasingly positive and curious about this new way of connecting music therapy and

physiotherapy, and was willing to help his physiotherapist in her music therapy education by being her patient for the ten sessions that form the core of this study.

### **3.3 Planning the therapy sessions with the patient**

The patient gave the therapist permission to make notes for the written report and to take video recordings of the sessions. He informed the therapist, that he liked to listen rhythmically, strong music. The genre of music was not so important; pop, rock, or heavy music suited him. He also said that he did not have a good voice for singing, and that he had “two left feet”. He absolutely refused to sing or dance in the sessions, and the therapist agreed to these restrictions in planning and conducting the sessions.

A simple and structurally and rhythmically exact tune was needed as the main accompaniment for the sessions. The lyrics should be so familiar to the patient that no effort would be needed to remember them. The children’s song *Hämä, hämähäkki* was chosen for this purpose: admittedly it may not have been the most obvious choice for a grown man, but because the patient refused to sing and didn’t read poetry he had no store of lyrics in his memory. He suggested this children’s song himself, and it was used for the ten sessions. The therapist suggested various type of recorded music as background music, and the patient had a preference for Irish traditional music, which provided a steady rhythmical boost for walking and marching exercises. The particular music chosen contained easily identified 8-count phrase structures. Short video clips of the sessions were filmed mainly by the therapist, but two were filmed by the clinic’s secretary.

The therapist did not strictly plan the exercises in advance. The rough design of sessions was planned to include a warmup phase, when the patient would move to music playing in the background. This was followed by a tapping (clapping) part, in which the patient would meet the challenge of performance to combine his own voice and tapping. In the next phase, the patient would be familiarized with some type of relaxing method, which he could use home later without assistant. In addition, every session was planned to begin with a brief repetition of the tasks of the previous sessions.

A few days before the ninth session, the therapist was introduced to functionally orientated music therapy by Jouni Kettunen in lectures at the Open University in Jyväskylä. The

therapist then decided to try this kind of action with the patient, and drumming and moving tasks were incorporated into the last two sessions. The guided the patient in learning to hear the structure of ordinary song music, to gain on conceptualization the structure of phrases. With the help of knowing, hearing the “patterns” of phrases, the patient would have the benefit, support for his movements. Children are singing or reciting rhymes while they are trying to learn to skip rope. The knowing certain accents of rhymes is assisting in amplifying coordination of movements, like skipping rope. The steady beat 4/4 was planed to be an easy way to recognize the phrases in the music. In easy Finnish folksongs and also marching music, there is possible to perceive the regularity of a coherent whole of 8 count accents. The therapist suggested various type of music on CDs for background music. The patient showed a preference for Irish traditional music, which offered a steady, rhythmical boost for walking and marching exercises. That particular music was built of easy identified 8-count phrase structures. For example, *It's a Long Way to Tipperary* is a coherent whole of 8 count accents. The music was used in the background in warmup parts.

For the warmup part, the therapist provided a model to move with music and change the way of movements when the next phrase in music started. The patient imitated the therapist’s movements and way of moving based on music. He tried to find the beats and phrases in music and show them in his movements. He concentrated to find steps on accents of music, to change the direction of walking or he tried to move his arms in the rhythm of music.

The tapping tasks required the patient to direct his hand or hands in the certain speed, using certain energy to a certain placement with a certain rhythm. The 8 hits phrase consisted of two 4/4 patterns. In the easiest 8-count phrases the two patterns were similar with each other on based of mount of hits or taps, on based of timing the hits or taps etc. These tasks were planed to become more difficult accordingly by demanding to remember the orders, the schemes and by demanding to change the way of tapping when noticing that the music or phrase was changing. In the beginning of each task the therapist told what to do, showed it and in some tasks additionally tapped with the patient helping him by offering him a mirroring model.

After having learned to identify the basic 4/4 rhythm, the patient learned to listen to 3/4-beat waltz music. As with the 4/4 music, the therapist helped in this by demonstrating with her movements the phrases and by swinging with the body to the tempo of the waltz. The patient tried first to imitate the therapist's performance. When the music became familiar to him, the therapist added the use of hands while stepping on one place or moving around in the room. The tapping tasks the patient and therapist occurred with counting aloud or reciting a rhyme or in the tempo of singing (by the therapist) or with recorded music.

For the drumming tasks the therapist used buckets instead of drums in the last two sessions, as no drums were available in the clinic. The buckets gave tactile feedback, similar to the vibration of drums. The sound of drumming buckets gave the auditory feedback of the motor performance, of the correct timing of movements. Because of the size of the buckets the hitting movements became wider, as in the tapping tasks. It demanded expansive movements of the hands in forwards and sideways directions, either away from or towards the body. The large movements demanded a large field for the visual conducting. The patient used his hands while drumming, and in some cases mallets. In the last session the therapist allowed the patient to use a real instrument, a xylophone and mallet, to play the chosen tune (*Hämä, hämähäkki*). The patient had to play the keys in the familiar rhythm and melody, but now by moving sideways with the mallet.

The training took place at the therapist's clinic in Lappeenranta, sometimes in the clinic's physiotherapy room (soundproof, 12 m<sup>2</sup>, a comfortable room with a big mirror on the wall), or in the big therapy room (16 m<sup>2</sup> and a big mirror on the wall) and in the group room (60 m<sup>2</sup>, three windows, two mirrored walls). The ten morningtime sessions covered a span of four months, from 16 November 2009 to 9 March 2010. The therapist had reserved half an hour each time for writing up notes on the sessions. The sessions were meant to take place every consecutive week, but some breaks in the continuity were unavoidable. The undoubtedly affected the overall success of the therapy: the memory traces would surely have been stronger if the sessions could have happened in smooth succession.

The most important thing in every session was the positive feedback. A person with a handicap, a stroke, has to manage every day with a wide variety of disappointments and embarrassments. The therapist intended to try to pick up on all possible positive reactions in every session. The encouragement, the positive feedback proved to be a powerful tool

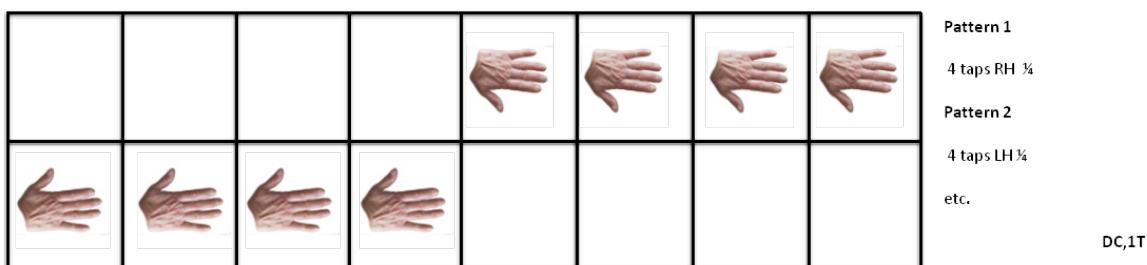
in rehabilitation. Any difficulties that occurred were discussed between the therapist and the patient, and the necessary lessons learnt from them.

The patient had problems with his working memory, which is typically for patients with stroke in cerebellum. He was not capable to receive new, complicated instructions. In sessions the therapist had to concentrate to give simple orders, instructions. The patient was asked to repeat orders before reacting. By repeating orders he was also training to win the difficulties in speech. Eye contact while speaking to the therapist or listening to her helped him to concentrate better. He easily allowed his gaze to move around the room and thereby loosed concentration in therapy activities. The environment was kept quite for the therapy (no phones, no others present). Visual feedback was beneficial in working with the patient. He often believed that he was performing the task correctly, but visual feedback helped him to realize the defects in motor tasks. The video clips were watched immediately after the tasks were completed in order to be fully aware of how the body really functions. The excerpts were not all saved, but were instead only used as tools for correcting the relevant movements. The mirrors were used as part of the feedback system.

The descriptions of every task and pictures of them are found in Appendix 1. For making the familiarizing to task easier for the reader I provide here some examples of the descriptions of tasks. These particular tasks were chosen based on the difficulties I found the patient to have with them. The chosen tasks with video analyses are tasks **4, 5, 11, 13 and task 19, variation 1**. The tasks are described in pictures of the two 4/4 patterns combinations, 8 squares for each hand. The four first squares are called pattern 1 and the latter four squares of the eight are called pattern 2. The pictures in the patterns are describing the way of working, with hand or mallet. The picture tells where to put the hand, on the table or on the knee, if the hand should tap the own side, or tap the opposite side=crossing the middle line. The picture tells also the duration of the tap; one hit in one square is 1/4. When the tapping hand was pictured between two squares, it showed the duration of two 1/4 = 2/4. If the pattern 2 was similar to the pattern 1, the task was added with the sign **C** (continuity). When the pattern 2 differed from pattern 1, then the task was labeled with the sign **DC** (discontinuity). If the tasks demanded only one target to tap, then the task was labeled with the sign **1T** (3 targets 3T etc.).

The pictures on the following pages illustrate the model of drumming, with the round figures showing the positions and amounts of the buckets and the boxes are describing the “felt drums”. The numbers and letters in the figures are illustrating the hitting hand (left L, right R) and order of hitting (1-6, or 1-8). If the hands are working simultaneously, the figures with R are having the same number as the figures with L. In the picture the reader is able to see if the patient is drumming with the mallets or with his hands. In the text beside the picture shows the beat and the direction of hits. The pattern 1 describes the way of drumming of three (3/4) or fore (4/4) first hits. The pattern 2 describes the way of drumming of the next three or fore hits. This combination of two patterns continues in drumming. The ways of tapping and drumming are exact described and analyzed later in this chapter.

**Task 4, video clip 3. (00:00:41):** The therapist started to modify exercises. The song was the same as previously: *Hämä, hämä-häk-ki, Kiipes langal-le -*



Picture 3: Task 4

The patient was asked to tap four taps with both hands. He tried to tap four taps each with the right hand, and then four times with the left hand and then forward similarly. First the therapist counted together with him. “1, 2, 3, 4”. in a clear voice and he tapped relative regularly 4 times on the table with the right hand (RH). Then he tried the similarly tapping with the left hand (LH).

00:00:07      The therapist started to read the rhyme (not counting), but the patient continuously counted 1,2,3,4. The taps of RH went well, but then with tap of LH came RH also with. The patient let it fall down, but with the fourth tap of LH the RH rose again and stayed up. It came late down and LH tapped once too much (5 taps).

TULI SADE RANK- KA = 4 taps with R, but they were not regular and there came one tap too many.

00:00:18 HÄMÄ- HÄKIN VEI - = 4 taps with LH. Taps were irregular (five taps). The patient lost hand control. After AU, the therapist stopped tapping. The whole time he had counted 1,2,3,4, but he had difficulties to find right numbers. The therapist told him to start from beginning again.

HÄMÄ, HÄMÄ-, HÄK- KI (RH 4 taps) KIIPES LANGAL- LE - (LH 4 taps)

TULI SADE RANK- KA (RH4 taps) HÄMÄ- HÄKIN VEI -  
(LH 4 taps)

AU- RINKO AR- MAS (RH4 taps) KUIVAS SATE- HEN -  
(LH 4 taps)

The tapping was more regular, but still very slightly irregular, and he still counted himself.

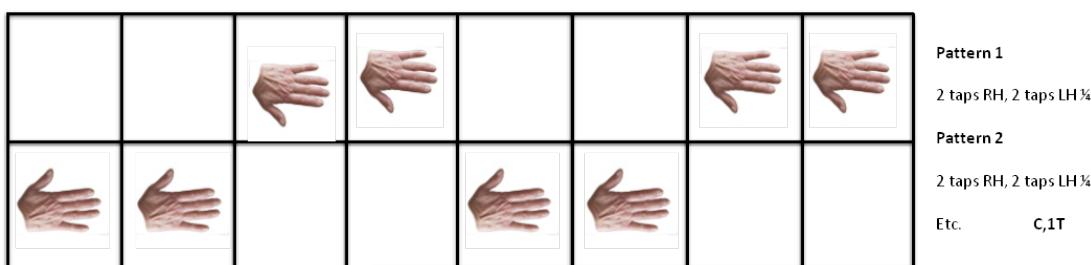
00:00:34 HÄMÄ HÄMÄ- HÄK- KI=, the rhythm broke down again, his RH tapped 5 times unregularly.

KIIPES UUDEL- LEEN=, his LH could not maintain the rhythm any more. The patient's counting was unclear.

00:00:41 The video clip was stopped.

Notes: The therapist had not noticed while selecting the task that difficulty may arise because of the previous task 1. In that task, the patient was asked to tap the phrase letting the tap on the last syllable stay and have a pause instead of a tap (the seventh tap 2/4). This previous way of tapping may have disturbed him in this particular task 4.

**Task 5, video clip 4. (00:00:15):** This preparatory exercise was done to learn the double tap. The patient was allowed to concentrate only on tapping and the therapist was counting aloud one, two, one, two etc.



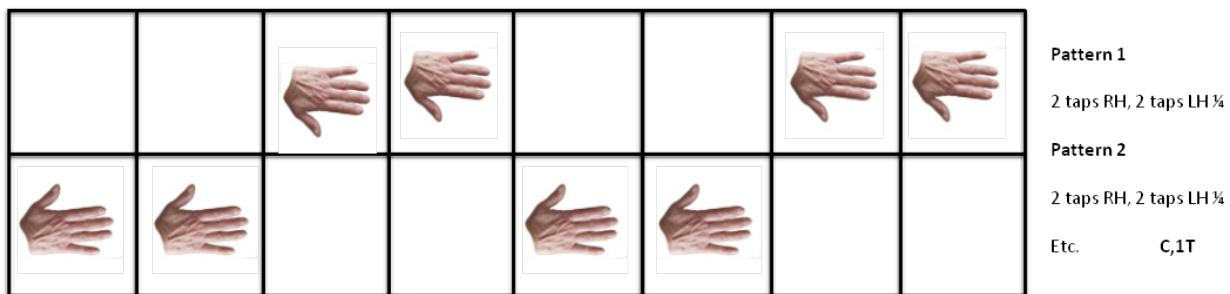
Picture 4: Task 5

The two first taps went correctly, but then the patient tapped with his LH only once. He continued again 1,2 (RH) and 1 (LH).

00:00:07 The therapist asked him to stop and start again. He continued like he had started. He did not change tapping. After noticing, that the patient's working memory does not accept any more new models of acting; the therapist stopped the exercise for a while. His capacity for concentrating on this kind of work was low.

**First Exercise to Prevent Fatigue (between tasks):** The patient was guided by the therapist to move on the trampoline and jump for a moment, after which he was again ready to face a new challenge and task 5 was repeated.

**Task 5. Video clip 5. (00:00:23):** The patient was tapping, and the therapist spoke the rhyme, lyrics. In this exercise he should tap twice with each hand: HÄMÄ, HÄMÄ (RH 2 taps), HÄK- KI (LH 2 taps) etc.



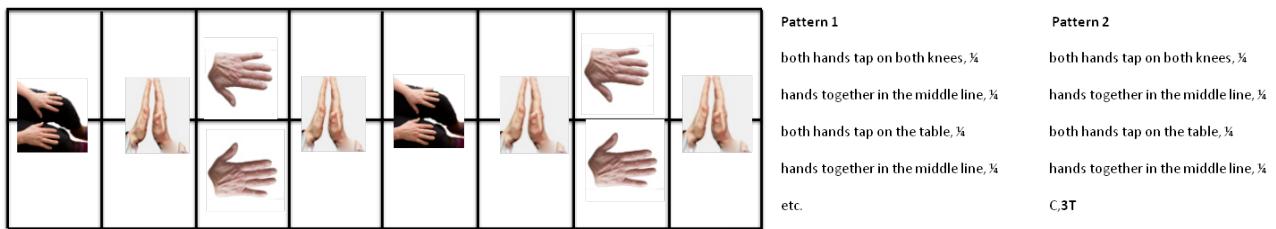
Picture 5: Task 5 repeated after the fatigue prevention exercise

00:00:15 KUIVAS SATE- (RH 2 taps) slightly unregularly, by -HEN syllable was the tap unsure, and the patient began to chuckle.

HÄMÄ HÄMÄ- HÄK- (RH involuntary 3 taps),  
-KI, KIIPES UUDEL- (LH involuntary 3 taps) LEEN (RH 1 tap).

Notes: The patient had made a real effort with these exercises. It was amazing how well he did the exercise on the video clip 5 after he had jumped on the trampoline!

**Task 11:** Duration of taps  $\frac{1}{4}$



## Picture 6: Task 11

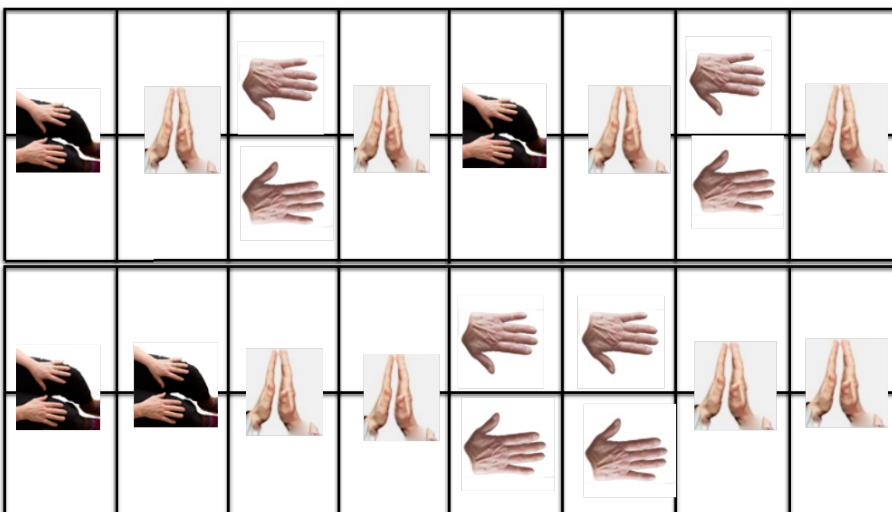
**Task 11, variation 1:** Task 11 + in addition, the patient was sitting down and marching with legs simultaneously paced with hands.

**Task 11 variation 2:** Similar to task 11, but every hit doubled, duration of taps  $\frac{1}{4}$ .



### **Picture 7: Task 11, variation 2**

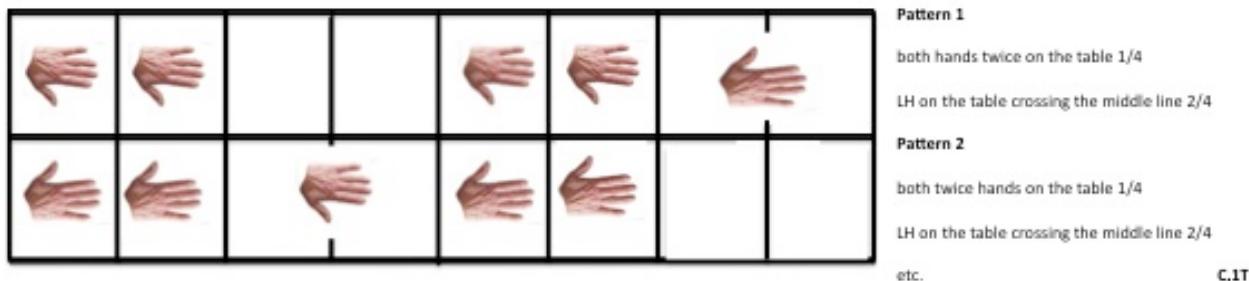
**Task 11** (with 8 accents) + **task 11 var. 2** (with 8 accents): As a last, and extremely demanding version of task 11, the patient had to mark out phrases by changing the pattern of tapping.



**Picture 8: Task 11 and variation 2 combined**

Notes: This session was amazing. The patient was able to concentrate for the whole session. He was listening very carefully to the therapist's singing while also following also the therapist's movements. Even though the whole session was only tapping and clapping, the patient did not lose his intensity for working. Both therapist and patient found the session successful.

### Task 13: Duration of taps 1/4, 2/4.



Picture 9: Task 13

**Video clip 6.** (cross-tapping, the first trial) (**00:00:10**): This video clip shows how the patient succeeded in the **task 13**: he and the therapist both recited the *Hämä, hämähäkki* rhyme.

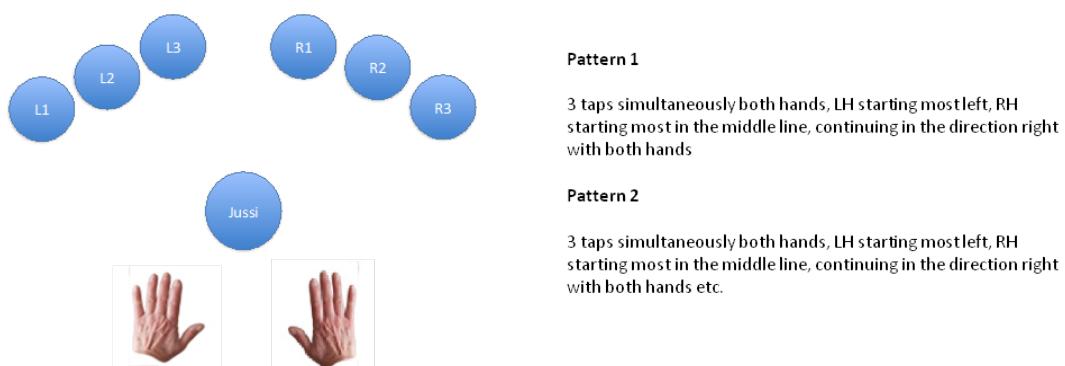
00:00:05 After having done the exercise once through, the patient forgot to leave the RH in place. He tapped with RH simultaneously while LH came crossing the middle line. He noticed it, and turned his head toward the therapist and camera. Still he tried to continue two seconds, but then he stopped.

**Video clip 7.** (cross-tapping, the second trial) (**00:00:21**): This video clip shows the new trial of the **task 13**. The patient tried the tapping first without the rhyme on the background.

00:00:05 He started to tap. The movements were not well coordinated. Timing of movements was not exact. Especially, the RH was late in every trial in crossing the middle line. The tapping with LH was inexact. Even though this tapping surely was difficult for the patient, he continued tapping. He did not lose his temper.

**Video clip 8. (00:00:15)** shows the third trial of **task 13**: In this case the therapist was sitting on the other side of the table, face to face with the patient. She was tapping and reciting the rhyme with the patient (The therapist stopped the speaking at 00:00:06, because he seemed to manage alone). The tempo was now higher than in the previous trials. The movements were exact and well coordinated. The patient's voice and pronunciation were clear.

**Task 19, variation 1: Video clip 17. (00:00:50)** The hands are working with mallets in a steady 3/4 beat, first simultaneously and then in a clockwise direction. 6 buckets were standing upside down on the table in front of the patient on the table, 3 on the right side and 3 on the left side in a figure of slight arc. The therapist sang a waltz called *Oi muistatko Emma*.



**Picture 10: Task 19, variation 1**

- |                   |   |
|-------------------|---|
| 00:00:00-00:00:10 | The patient tried first to tap only the movements of the RH, and then separate movements of the LH.   |
| 00:00:11-00:00:15 | The 3 first simultaneous taps with both hands went well, but then the patient did not find the exact movements of the RH. The timing of movements of the RH did not match with the LH. He forgot to tap the second bucket with the RH, or he tapped twice on the first bucket instead of tapping the second one. The LH found the buckets in the right order and the taps were hit nearly in middle of each bucket. |
| 00:00:17          | The patient tapped with his LH the bucket which was in area of the RH   |

00:00:19	He tapped the middle bucket twice with his LH. The therapist asked him to put the hands in the right position and start again from the beginning.
00:00:23	The patient put his LH strongly on the bucket and slapped it and was smiling to the camera.
00:00:26	LH went correctly, but the RH did not find the third tap in the right timing.
00:00:29-00:00:30	These 3 taps (3/4) were well done.
00:00:31-00:00:33	The patient had difficulties in deciding where to put the RH
00:00:34-00:00:36	The next 3 taps (3/4) were done at the correct tempo.
00:00:37-00:00:40	The tapping was not successful. The therapist asked for a restart.
00:00:42-00:00:50	The patient tried to find the right movements on the right buckets, but missed.

Notes: the patient concentrated very intently, and seemed very tense. The mouth and lips were moving with the work. It turned out that the exercise was too difficult for him. The rhythm of waltz was the patient in his efforts. The voice of the therapist was friendly; she was not blaming him for his mistakes. It was difficult for the patient to decide where to tap and when. The therapist slowed down the tempo of singing, when she noticed, that the patient could not follow. He would have needed a break between these exercises. He did not lessen his good mood in the work, but maintained his enthusiasm throughout the session.

### 3.4 Specifying and categorizing the exercises

“Playing” with the hands was done in different ways: either with one hand on the same side of the body (ipsilateral) or on the opposite side of the body (contralateral); with both hands on the same side of the body (ipsilateral), or with the hands playing on the opposite (contralateral) side.

#### **The target for taps or claps:**

- The table (hits with hands or mallets)

- No accurate target on the table, only the side of body
- The target on the middle line
- 1-4 marked targets, “drums” for each hand/mallet on the table= buckets or drums of felt
- Xylophone
- The patient’s own knees
- The patient’s own hands
- The therapist’s hands

For “playing” with the feet, the target for tapping was either the floor or step-boards. Tapping tasks with the hands were accompanied by a rhyme, with either the patient or the therapist reciting, or both together, and a count from one to four, or with music in the background. The pattern was as follows: 1. The left and right hand were tapping in turn to a steady beat. 2. The hands had their own role in relation of timing (not symmetrical timing). 3. The hands were tapping a target simultaneously. 4. The hands and feet were working together, either with a steady beat and simultaneous movements (right hand, right foot or left hand, left foot), or working non-symmetrically (marching style). This was practice for being able to change the way of tapping when the music was changing or when certain extents of phrases were done. The rhythmical task was mainly consisting of a coherent prime block of whole of 8 accents. In that block there were two patterns, each lasting the time of 4/4. In rhythm of waltz the patterns were consisting of 3, 1/4 lasting accents. Challenge of the tasks could be increased by creating two differing patterns, like timing the taps or role of hands. To change the model of tapping after every 4/4 pattern is straining for the working memory of the patient.

The tasks are categorized in Appendix 2. The symbols used are written above and described challenging factors in the tasks, based on hand movements and types of tapping. The tasks written in red are tasks in which the patient had problems.



Crossing middle line



Challenging choreography of hand movements



Different timing of hits



Amount of hits

**C** continuity (the first and second patterns are equal)

**DC** discontinuity (the second pattern differs from the first)

#### (1T) One target to hit with each hand at the time:

The task demands counting: The two patterns 4/4 are similar, C (task 5), or the two patterns 4/4 are different, DC (task 4, rudiments 7+9, and 8+10).

The task demand changing the single tapping hand: The two patterns 4/4 are similar, C (task 7), or the two patterns 4/4 are different, DC (tasks 1,7var1).

Hits cross the middle line: The two patterns 4/4 are similar, C (task 13), or the two patterns 4/4 are different, DC (the patient's variation of task 13).

Hits times in two different ways: The two patterns 4/4 are similar, C (task 8var2), or the two patterns 4/4 are different DC (tasks 8, 8var1).

#### (2T) Two targets to hit:

Two targets to hit with each hand at the time (simultaneously with both hands), with the hits crossing the middle line, or with two similar 4/4 patterns (C, tasks 9, 9var1), or two different 4/4 patterns, DC (No tasks).

#### (3T) Three targets to hit:

1) The hands are clapping together in the middle line, with the two 4/4 patterns being similar (C, Tasks 6, 10, 10var1, 11, 12, 15), or with the two patterns 4/4 are different, DC (no tasks), or 2) The two patterns 4/4 are similar, C, but continuing immediately with double tapping next 8 accent (task 11var1).

#### (4T) Four targets to hit with each hand:

No crossing of the middle line and with the two patterns 4/4 are similar, C. (no tasks), or with the two patterns 4/4 are different (task 14).

Crossing the middle line and the two patterns 4/4 are similar, C. (no tasks), or the two patterns 4/4 are different, DC (task 20).

### **Drumming on 2-8 buckets or felt drums:**

- 1) The hands (or mallets in hands) work one at a time and on the ipsilateral side of the body (own side) in the same direction with a steady 4/4 beat (no tasks), or in the mirroring direction (tasks 16 and 17) steady beat 4/4, or on the contralateral side (crossing the middle line), either in the same direction (no tasks) or in the mirroring direction steady beat 4/4 (tasks 17var2, 24), or with a steady 3/4 beat (tasks 22, 22var2).
- 2) RH plays the xylophone with a mallet in the middle line.
- 3) The hands (or mallets) work simultaneously, either a) on the ipsilateral side (own side) of the body either in a clockwise direction to a steady 4/4 beat (tasks 16var1, 16var2, 17var1), or to a steady 3/4 beat (task 19var1), or in the mirroring direction steady beat 4/4 (tasks 18, 21, 23, 24var2), or with a steady 3/4 beat (tasks 19, 22var1), or b) on the contralateral side (crossing the middle line), clockwise (no tasks), or in the mirroring direction with a steady 4/4 beat (task 24var1), or with a steady 3/4 beat (no tasks).

The categorized tasks are defined in Appendix 3. Every session was defined separately. The vertical columns were tasks conducted in the sessions. The tasks painted in green were the filmed ones. The horizontal columns were observations of the performances. If the performance was running without difficulties, it was scored with **ok**. If there were some inaccuracy in the task, it was scored with **ok -**. If there were difficulties in the task, it was marked **"Prob"**.

In the “Therapist Singing”, “Reciting”, “Background Music” column, the letter informed the way the therapist was accompanied the patient, e.g. **M** informed that there was CD-music in the background. **R** informed that the therapist was reciting a rhyme or numbers as aaccompaniment. **S** reported of the accompaniment by therapist’s singing. The “Repetitions Until Successful” column records how many times the patient had to do the task before it became fluent, if the tasks did not succeed the first time round (which they often did).

## **4 DISCUSSION OF THE MUSIC THERAPY SESSIONS**

This chapter provides more detailed reflections on the tasks outlined in the last chapter. A general point to make at the beginning is that those tasks that I had in advance suspected would be very difficult for the patient proved not to be. Surprisingly, many of the more complex gave the patient little or no significant difficulty.

### **4.1 Some difficulties with the tasks**

I begin this chapter with a discussion of the tasks which did turn out to be most problematic for the patient, namely tasks 1, 4, 5, 8var.2, 13, 15, 8+10rud, 7+9rud, 5rud, 6rud, 18 and 19var1. Perceived problems in performances were found by using the categorization of tasks (more detailed description in Appendix 3). In overall, the patient seemed to have difficulties in modifying his way of functioning and moving. Maintaining the steady beat in movements was challenging for the patient. His impairments of working memory caused him problems in finding the right timing and placing of hand movements.

Task 1 (video) was difficult for the patient in the first and second session. The task 1 required many repeating. Later the performing was easy. Task 1 was categorized “1T,DC”, “different timing of hits”, and “challenging choreography of hand movements” (see appendix 1, picture 11).

Task 4 (video) was trained only in the second session. It required 3 repeating's before succeeded. It was categorized “1T,DC”, “Amount of hits”, and “challenging choreography of hand movements” (See text, picture 3).

Task (video) 5 needed to be trained in the second and third sessions. It required many repeating's. The task 5 was categorized as fairly easy, “1T,C” and only one challenge was noticed: “Amount of hits”. “Rebooting brain” helped the performing to succeed. Perhaps the difficultness in the task was the tiredness after many brain straining tasks (see text, picture 4).

Task 8var.2 was trained in the session 5, repeated 3-4 times before succeeded. In the session 6 it was still difficult. It was categorized “1T,D”, “Different timing of hits” and “challenging choreography of hand movements” (see Appendix 1, picture 28).

Task 13 (video) was trained in the session 6 and it required many repeating's. It was categorized “1T,DC”, “Different timing of hits”, and “Crossing middle line” (see text, picture 9).

Task 15 was trained in the session 7 and it required many repetitions. The task was to remember 3 targets to hit (3T), but the first and second pattern were similar = continuity(C). “Crossing the middle line” was the challenging factor in the task. The patient had problems in the regularity of tapping and in coordination (see Appendix 1, picture 32).

Rudiments 8+10 and 7+9 (video) were trained in the sessions 7 and 8 and in both sessions many repeating's. They were categorized “1T,DC”, with challenges like “Amount of hits”, and “challenging choreography of hand movements”. The patient had problems in the regularity of tapping and in coordination (see Appendix 1, pictures 35 and 36).

Rudiments 5 and 6 (video) were trained in the session 8 requiring many repeating's. They were categorized “1T,DC”, with challenges like “Amount of hits”, and “challenging choreography of hand movements”. The patient had problems in the regularity of hitting and in coordination. The problems in performances in that session came up probable because of patient's tiredness. The end part of the session was problematic in performances (see Appendix 1, picture 38).

Task 18 (video) was trained in the session 9. The patient was playing with mallets having problems in the regularity of hits and in coordination. The mouth made associative movements (see Appendix 1, picture 44).

19var1 (video) was trained in the session 9. The patient was using his hands in drumming. The patient had problems in the regularity of hitting and in coordination. The trouble seemed to be in the phase of upper limb movements (see text, picture 10).

The xylophone playing was overall too difficult to perform without mistakes. The patient chose the mallet in his right hand, which was not working as well as the left hand. The hits with the mallet were unsure and his grip was unstable. The keys in the xylophone were too small to hit with the mallets, the task was too demanding for the patient.

In the last two sessions (9 and 10) the patient had drumming exercises on playing “drums” (buckets and felt pieces). The therapist was imaging beforehand that to play drums would be challenging for the patient. The buckets were not all similar with each other; there were variability in highs. The buckets were standing upside down on the table, which the therapist could adjust to stand lower providing a proper height for playing. The drumming in the settings requires expansive movements with the hands, from middle line to measure of the forearm in an arc. The steady beat should be maintained. To adjust movements, hits on the accents were challenging, when the patient had to move the hand from distantly again back to near middle line between the fourth and fifth hits (as in task 17, see Appendix 1, picture 41). Drumming demanded large visual area in eye movements, when both hands were simultaneous reaching sideways, more than 1 meter between hands (like in tasks 18 and 19, video clips, see Appendix 1, picture 44, 45).

Adjusting timing of hits after crossing arms position: when the hands were working on the contralateral area (crossing the middle line), simultaneous or one at the time, the challenge was to adjust the line of movements so that the hands were not running against each others (like in task 24, video clip, see Appendix 1, picture 54) and although holding the steady beat.

The direction of movements of hands in drumming was varied in either a mirroring direction, or in clockwise or anticlockwise directions. In the mirroring direction, the natural movements of arms are the mirroring movements, when the arms are moving both simultaneously with same muscle groups, like the movements, when a person is aiming to take a child and lift it. Arms are coming toward each other, from own side to direction middle line or even over it to the contralateral side. The physiotherapist had chosen without purpose mostly such movements for the tasks, perhaps because of the natural quality of them. 13 of the 17 drumming tasks were mirroring movements. In the clockwise or anticlockwise direction, the arms may be working in the same direction, alone or both together simultaneously. Of the 17 drumming tasks, 4 were of this kind.

The patient did not find the drumming tasks difficult. The only challenging task for him was the one on the video with 3/4 beat and where drumming movements were simultaneously, clockwise in reading direction. Whereas the steady 4/4 beat seemed to be the most suitable for the patient, the 3/4 rhythm gave him challenges in moving exercises and also in this drumming task. The steady 4/4 beat is easy to identify in every natural environment, in human body (heart, breathing), in natural movements of a human being. The challenge in the task was not the large visual field to govern, because the patient worked through tasks 18 and 19 easy, without problems, even there was also the rhythm 3/4.

Regarding the phase of movement, the noteworthy issue probably was the relative phase of arm movements in the task 19var1. The hands were working towards same direction, but because of different phase of movement (the left arm was moving from side towards middle line and the right arm was moving away of middle line in direction to side = relative phase was 90 degree) the movement was more difficult to execute. The upper limbs had to "jump" a long distance in short time back to the starting positions. Task 17var1 required same degree of phase in movements, but the upper limbs returned backwards without "a jump" to starting point. The patient did not have difficulties in the task 17var1(see Appendix 1, picture 42).

In the previous drumming tasks, the patient used mallets. In this particular task he had to find the hit on the bucket so, that he got a sound of it. When the hit is not exactly in the middle of surface, the hit does not sound. The therapist did not offer the rhythm as slowly as it should have been offered. The therapist should match the background music in the speed that patient may be able to follow with movements.

#### **4.2 Multisensory activation in rhythm-aided rehabilitation**

The use of rhythmical tools in therapy was new to the therapist. She had to improvise and apply the ideas received based on lectures and literature. The therapist was not very experienced with cerebellar stroke patients. The patient had many "hidden" functionally problems although he seemed to handle his life somehow. The main positive issues will be discussed in the next sub-chapters.

### 1) Fatigue

Fatigue may manifest itself in tiredness of muscles or in mentally working. The troubles with fatigue came up in the therapy sessions after a lot of physical loading. In those cases the difficulties came up motoric with problems in keeping the rhythmicity of movements or mentally in remembering the order of tapping the mount of targets. The therapist had not considered the most adequate time limit for the therapy. The patient did not recognize the fatigue, he did not feel himself tired or too stressed and did not lose his temper.

There are remarks in the literature of the importance to take into consideration the time limits for the therapy of neurological patients. According to Baker et al. (2004), the predisposition of stroke patients for fatigue should not be underestimated of clinicians. It should be recommended to work shorter sessions than 40 minutes for neurological patients.

Cognitive overload was another matter to be taken into account. Throughout the whole process, the therapist tried to maintain a positive attitude and a therapeutic climate. When it was noticed that the patient was getting too strained, the therapist did not want to push him to try harder. She did not want to get him to face disappointments because of too strenuous tasks. She came to the idea of leading his thoughts to a new direction and let difficult task to be forgotten. The therapist gave the patient some very differing tasks in between the cognitive stressing tasks. Instead of counting taps, or leading hand to some direction, he was asked to jump rhythmically on the trampoline or to draw very big circles with his hands on the surface of the table. One extra task for relaxation in between was the intelligence task with writing numbers in a certain order in area of 36 squares on the sheet.

### 2) Rebooting the brain

While directing the concentration in a very different area, working there a little while, 30-60 seconds, was “saturating” the fatigue away, decreasing the overloading. After a little break the patient was able to win the difficulties and performed the problematic task perfectly. One of the most interesting issues of the music therapy sessions proved to be this finding of how to overcome the cognitive overloading of cerebellar stroke patient.

I had been earlier aware of the fact of fatigue with neurological patients. As only tool for gaining the fatigue, I had only known to let the patient rest for a while. In this study

described particular way of permitting the brain to rest while offering some different task to operate with was a new idea in the music therapy arisen in my mind as a therapist. Like when a computer is miss functioning and not obeying the user, a valuable trick is proved to reboot the computer. Perhaps we are rebooting the brain by offering some new kind of challenge for it?

### 3) Learning to hear the structure of music

In the beginning of every session was the warming-up part, where the therapist and the patient did move in the rhythm of music and tried to recognise the phrases in the music. The therapist used marching music and additionally waltz music 3/4. The patient seemed to need more support of watching therapist's doing in movements or steps with waltz music. He found the steady 4/4 rhythm in him self easily. He apprehended the motor performing to 3/4 music more like dancing, and perhaps therefore he had little difficulties with it. The therapist had on CD Irish singalong music, with marching music and 3/4 beat music also. The therapist noticed that for this Irish waltz music the patient did not have any prejudices. They were easier to use on background than the more familiar Finnish waltz music. The steady 4/4 beat was used in mostly every tapping task by the therapist in first eight sessions. In drumming task in two last sessions the therapist did sing 3/4 music in the background (described in 4.3.1). The difficulty seemed not to be the rhythm, but the targeting and directing movements. Step by step, after many repetitions of listening exercises, the patient did learn to hear the structure of phrases. He found the right moment in the end of a phrase, to turn the direction while he was marching. He learned to show by lifting his arm, as he noticed a new phrase starting. First he was observing the example of the therapist. Later he noticed himself the right moments to act. The therapist tried to make the tasks more complicated and demanding by adding more directions to change the movements or by adding more kind of activities to change while phrase was changing. Patient surprised himself and the therapist by learning relative easily to mark the end of phrase by clapping hands together (see the video on the session 6) based on visual mirroring the therapist.

### 4) Two-limb cyclic movements

I was not aware of the crucial factor of the two-limb cyclic movements in the time of the ten music therapy sessions. During the writing process of this particular study, by becoming acquainted with the large literature I became to know why some tasks perhaps were

difficult for the patient. I realised that by demanding movements of upper limbs like in the task 19var1, I had created an enormous difficulty for the patient. The movements in the task 19var1 are unnatural, the phase of movements are 90°, which is rather seldom used in human motor performance. It is unnecessary to ask the patient to negotiate with too demanding tasks. The degree of difficulty tasks has to be evaluated very precise.

The coherent, cyclic two-limb movements are reported to be more stable and demanding less attention than the incoherent movements. The most stable and exact are the coordinated movements of the upper limbs combined with simultaneous activation of identical muscle groups on both sides on the body, moving in the same direction. (Sandström and Ahonen, 2011.)

#### 5) Well-functioning relationship

The pedagogical relationship cannot be fulfilled only from therapist's point of view but also therapist's ability to create a connection with the patient is essential. The connection may establish only by listening, with common well-known words that are understandable. The understanding of each other is found as precondition for learning. The patient may acquire a new way of life, when he understands and is able to apply new kind of actions in real life situations. (Piirainen 2006, p.201.) In the study advantages were found in using elements of music therapy in the rehabilitation process.

#### 6) Toleration of repetitions

Before the speech therapy sessions the patient was motoric apractic in combinations of some letters. He did use his weak voice, and cleared his throat often while speaking. By being forced to concentrate to his motoric in hands and feet, he forgot to be timed with his voice. He repeated same sentences several times maintaining the interest in movements of limbs. The repetitions of same sentences would have induced the patient to loose the interest in training without these added challenges of motoric tasks.

#### 7) Fluency of movements transferred in motor functions of daily living

The patient did have difficulties in skiing. He did not find the way to use strong kicks downwards with the feet while skiing. He could not find the timing and synchronisation of using skiing sticks and skis. The multisensory rhythmic training may have been helping him by timing and synchronization of own movements and skiing technic, because in that

particular wintertime he found the efficient way to ski like a man. He found the right timing of simultaneous strong kicking the ski and pressing the skiing stick. He also had did have difficulties in timing jumps and with synchronisation of whole body movements while jumping over a little bar, or moving rope. Jumping on a trampoline was difficult to him. After the 10 sessions of rhythmical tasks he found the energy saving and synchronized way to jump. The whole body participated appropriately in motor actions.

#### 8) Multitasking

The simultaneous cognitive and motor working was impossible for the patient before music therapy sessions. He could not discuss with his wife while walking, he could not make notes of surrounding traffic while discussing with someone and simultaneously walking. After the music therapy sessions the wife of the patient reported the increased ability of the patient in discussing and doing something motor actions. By cycling he could better hold the steering stable regardless of turning head from side to side. The rhythmical exercises have proven efficient help for reading tasks. Jussi improved the speed of reading, and his wife reported that was reading aloud to her the texts of films in Finnish, which was earlier impossible. The motor performing of speaking ability was increased.

#### 9) Increased self-confidence and energy for own rehabilitation

The process of the ten sessions gave extra energy to the patient. He perhaps felt to have some special attention concerning only him. He seemed to like the challenges of new working style. The patient started to record some of his actions home on video and inspect them as an interesting material, like walking style, the balance while turning by walking. He started to participate in a group-gymnastics for women, because he had not found a group for men. He found the group inspiring and challenging with the use of music in it. There were same kinds of rhythmical movements like he had in the music therapy sessions. The patient started additionally to go to gym. He was not timid to perform among strangers. The neurological patients are feeling alienation in relation to their body. The impairments in their abilities in physically and psychologically functions are shamefully. To become estranged of own body, this shamefully impairment activates the patients to search for help from the therapist and start the personal process for recovering (Piirainen, 2006, p. 42).

#### 10) Activation for verbal expressions

During the process the patient and therapist discussed the patient's experiences and feelings. I was willing to lead him to practice to express himself in words. He told to have realized new aspects in himself and that I as therapist had helped him to gain more competencies. By using more verbal interaction in the therapy we were building a deeper connection with each other. By leading the patient to use more verbal acting I was helping him to connect him in his feelings and to conceptualize him possibly new dimensions, which he would not have found alone. In the rehabilitation relationship the patient will not be only an object of the therapy, but also an active actor in his own life with the guidance of a therapist (Piirainen, 2006, p. 159).

#### **4.3 Rhythm and accuracy of motor functions**

During the writing process I became acquainted with the work of the nineteenth-century music pedagogue Émile Jaques-Dalcroze (Juntunen, 2004). I found many similarities between my own ideas and those of Jaques-Dalcroze. The pedagogue had noticed, that rhythmic musical sensations activate the motor and nervous system of the whole body. According to Jaques-Dalcroze, children should experience music with their whole bodies, learn to move, sing, and hear before they start to learn to play some instrument. He encouraged his students to become aware of the rhythms of their body movement, to recognize the rhythms of music, and to realize them in movement. He had noticed, that his students sang more musically when incorporating rhythmic gestures. For Jaques-Dalcroze was the developing the sense of time particularly important at the beginning of training. His teaching started, for example, by experiencing the steady pulse in walking; because walking incorporates voluntary muscles, Jaques-Dalcroze believed it is a natural basis for studying rhythm (quoted in Juntunen, 2004). A similar conception of the importance of rhythm in therapy is stated by Tomaino (2009 a):

Some internal rhythms can come to match external rhythms. In effect, a rhythm in the external world is heard and internalized, evoking an answering rhythm within us. When we understand how and when external auditory rhythms, or cues, influence various internal timing mechanisms, rhythm can become a powerful therapeutic tool.

According to Wulf and Mornell (2008), the auditory models may be rather powerful in

facilitating the learning of movement sequences. The results of their study of musicians learning styles showed that the accuracy of the relative timing was enhanced by the auditory template. In fact, there was no difference between the groups that practiced physically and those who learned through observation. However, physical practice was required to enhance absolute timing. That is, absolute timing was only improved when the auditory model was coupled with physical practice. When in their study the auditory model was presented prior to each practice trial, performance was enhanced almost immediately, indicating a strong guidance effect of the information. Importantly, the benefit of the auditory model carried over to the retention test where the auditory model was removed. (Wulf and Mornell, 2008.)

Because of variation in patients' problems, the ways of working with them may vary and the tools needed may vary. Based on the initial evaluation the therapist should choice carefully the way of working and tools to work with. With consent evaluation during the process the therapist is able to change the way of working. "Conducting an assessment enables a therapist to gain insight into a client's personal traits, functioning and overall situation, and to further determine possible problems, needs and resources from a clinical viewpoint" (Ala-Ruona 2007). Rehabilitation of neurological patients requires intensive, emotional and cognitive exertion both of the patient and the therapist. By increasing the activating contents of therapy, the therapist may enhance the interest of the patient to invest more concentration in the tasks presumed. To wake up the curiosity of the patient for more demanding training is a challenge for the therapist. For the long lasting rehabilitation process the music elements have a potential activating attribute, which every therapist should try to incorporate in his or her work. By incorporating elements of music therapy in the physical rehabilitation the therapist provides significant activators in motivation for goal directed, repetitive, functional and progressive in complexity motor training.

Ahonen (2000) warns music therapists against the categorizing music therapy process into particular rigid models. With clinical experience, by integrating practical knowledge with the therapist's own theoretical knowledge and by filtering this material through the therapist's personality, the music therapist is able to build herself a suitable framework and the suitable way to work during the rehabilitation process. In Ahonen's (2000) view, it may be fruitful and may product new ideas while working by creating a framework of therapist's

own, which is based on a combination of her own experiences and various theories. Hence clients always are individual as well the therapists, it may form many different ways of doing music therapy (Ahonen 2000, p. 114). Music gives an initiation for movements, like the hands of physiotherapist may give the stimulus for patient to react with motor response. By using recorded music, the therapist is able to select the type of music needed for the motor performance. A very activating element is to let the patient self to choose the recorded music for the training. The preferred music enhances the mood and may better motivate the patient. Music may provoke physiological, psychological and cognitive reactions in a human being. The harmony, tempo, structure, tension of music has to be carefully estimated based on the goals of the therapy. In particular, the music for relaxation should be chosen very carefully.

**Rhythmic use of voice as stimulus:** The therapist noticed in the music therapy sessions that she did not need any CD player or computer for the motor exercises. She found her own voice as an instrument. Rhythmical speech of therapist and/or of patient acts as a strong stimulus for movements. It is not needed to be a singer, if the therapist is willing to add the singing for stimulation of movements in therapy. The therapist is allowed to sing in his or her own voice. The main aim is to provide rhythm for the singing. The tempo and rhythm should support the movements, the speed, and characters of movements. By singing the physiotherapist may encourage the patient with speech impairments to express himself in singing. The words are easier to formulate when the text of the song is familiar to the patient. In singing together the therapist and the patient are in shared, common world, which is reinforcing the therapeutically relationship.

**No need for real instruments:** Musical instruments are seldom available in the physiotherapy clinic. Drumming and tapping are applicable ways to offer repeated, exact directed movements for upper limbs. For drumming the therapist may find various kinds of surfaces of tables, stools, and boxes. As drums the therapist may use bowls, containers from kitchen. If the therapist is willing to try to use musical elements in the rehabilitation, it is not needed to invest for real drums in the beginning. The imagination creates the limits. The buckets used in this study gave a good sound for drumming, but made additionally big noise for the ears of patients in the neighborhood. The felt drums did make no noise at all, but lying on the table, they sounded a bit like drums. Felt drums created an illusion of playing real drums. They additionally gave an accurate target to hit. The different-colored

felt targets were easy to identify and name.

**Experience of skillfulness:** In the case described in this study, the patient enjoyed training with rhythmical tools. He found exiting the challenge to do something so different, atypical from ordinary physiotherapy, which he was familiar with. The therapy got a kind of stamp of specialty. The patient was not conscious of his ability to sense the rhythm of songs and music. He was surprised, that he could distinguish the phrases in music and accomplish phrases in his motor performing.

Furthermore, he was astonished at the easiness of playing the xylophone. He had always thought not to be clever enough to play an instrument. He came to realize that playing an instrument is an attainment that any person may acquire. Musical talent is not essential. Patients with neurological impairments invariably lack self-confidence; every experience of skillfulness in the physiotherapy is needed. The music therapy sessions seemed to improve the patient's self-confidence with positive experiences and to promote him variety for the rehabilitation process, like he was wishing in the beginning of the therapy sessions.

**New ideas for learning skills:** The next sub-chapters are opening the ideas of the writer to transform new elements for rehabilitation.

To adopt new ideas in learning skills is reasonable. Patients in acute phase rehabilitation hospitals are beside the primary therapies spending largely time alone in their beds. The patients could be offered to see on the television screen instead of movies, some motor actions, and dances with music and rhythm. Patients would inflect positive for the motor performing by watching healthy persons movements.

The observational practice has been demonstrated to be a viable method of practicing motor skills. The observation of demonstrations by a model seems to be particularly effective for the learning of complex skills. The possibility of using observational practice to replace extended hours of physical practice could be of immeasurable significance. The observational strategy is used for training musicians. (Wulf and Mornell, 2009.) The method applied to rehabilitation could save wear and tear on the muscles since many of the same brain regions are activated when one watches someone else do a task, as when

one does it oneself; although some muscles are enervated in the process, they are not subject to the same strain as they would be in actual training.

Modern technical equipment enables to record the motor performances of stroke patients and lets them analyze own performances with the therapist. Own impaired motor performing is easier to recognize on the screen than sense it in own body. Based on recognizing the problems the patient is more able to retrieve the motor performance. Beside the benefits of realizing own impairments, there may certainly also be for the patient a threat of disappointments and therefore negative mood.

Positive attitude of the patient: The process reported in this Master's thesis proved to be successful. Certainly one significant cause was in this case the positive attitude of the patient; the growing-up man was willing to do tasks by reciting the children rhyme and to do some funny moving with music. After three year's education in music therapy, I would choice instead of rhymes the ordinary words, not children rhymes for a growing-up man. The recited words used in tapping tasks as stimulators could be e.g. names of the targets to hit; knee, table, left, and right. Numbers would be suitable to recite while performing motoric. To recite the two-pattern phrases as a fluent rule for tapping performance could be challenging for the working memory. The recited rhyme may perhaps not require enough challenge for the verbal memory; it may prove to work too automatically.

#### **4.4 Increasing the level of difficulty for motor performance**

Rhythrical exercises have shown their suitability for rehabilitation of stroke patients. The tasks in the method presented in this study are easy to modify. The patterns are the basic elements.

1) Extending the mounts of patterns for a phrase: The amounts of certain tapping or drumming patterns in this clinical training described earlier in the thesis was only two types in one task, either similar, continuously (C), or differing from the first one, discontinuously (DC). To increase the grade of challenge for memory could happen by increasing the amount of patterns or by planning the tasks so, that several patterns (4/4) will be

connected with differing, discontinuing patterns (4/4) for a longer phrases and played them without pauses in between.

2) Increasing the grade of requirement for body stability: By carefully assessing the grade of motor abilities of the patient, the therapist is able to choice the position suitable for music making, rhythmical tasks. The most important issue for therapist working with neurological patients is to create the positive atmosphere for the rehabilitation. Too easy position is not directing action towards goals; too difficult position of patient may inhibit the fluent motor performance and provide a negative disappointment. One other of the important goals for rehabilitation for neurological patients, like stroke patients is the increased ability of holding stability and regulation of balance in movements. For to get more stability for body, the activation of the deep middle body muscles should be noticed in every motor task of stroke patient. The therapist may vary the initially positions for tasks. To work standing, sitting on a stool or on the floor are different on demands for balance. Kneeling, or standing with one leg on a low chair, or to stand with one foot in front of the other are ways of increasing the level of difficulty of the tasks.

3) Increasing the grade of requirement for balance: The stability of the platform for working is effecting on motor performance. The more stable and large is the platform for the patient, the more stable and sure is the motor performance and the patient is able to concentrate on rhythmically tasks with hands. When the rhythmically working with hands is fluent and not anymore requires concentration, the therapist may add the instability of platform as a challenge for the patient. The patient may e.g. sit on a big ball, or there may be a balance disc on the stool to sit on while tapping the table. In the standing position, the challenge may be increased for the patient by adding a thick, soft platform to stand on. Alternatively the patient would stand on a balance plate, or on a trampoline while drumming or tapping with the therapist.

4) Increasing the challenge for motor and working memory: At the point when some new challenge in the therapy is needed, the combinations of tasks described above are suitable. To move, to take steps in certain limited time, during certain phrases and to insert working with hands in accurate timing is increasing the challenge for motor and working memory. By adding changes of direction, the amounts of steps or tapping, clapping, drumming the therapist is able to increase significantly the challenge for the working

memory. When the patient has developed with the motor tasks, he may be ready for working rhythmically e.g. with a ball. The patient may bounce the ball and recite the counting 1,2,3,4 and throw the ball on the wall, catch it and throw again, catch it in the time while counting 1,2,3 and 4. He would have to regulate the throwing and catching to keep the steady beat. The patient may jump on the trampoline and throw the ball to the therapist and hold the steady beat by counting aloud or reciting some rhyme. The more the motor skills are improving the more difficult the therapist may develop the tasks for to remain the interest of the patient. The skills retrieved in the rhythmical tasks should be transferred in real life actions, like playing tennis or badminton, or dancing. When the skills are retrieved in daily use, they may stay in the motor memory.

5) Waking up own interest in acquainting oneself with new research: therapists doing rehabilitative work face daily the limits of time and cost in targeting their help for patients, in aiming to maximize the independence of those with impaired functions. To give their patients the best possible chance of therapists should make use of a wide scale of research studies to help in considering new methods, and new and innovative combinations of existing perspectives and methods from different fields.

## 5 REFLECTION

### 5.1 Validity of the study and lessons learned

Validity issues were carefully considered during the study. In order to produce a valid thesis it was important to define the concepts related to the novel topic since no previous studies on the current topic could be found. Sources were searched for the literature review concerning cerebellar stroke patient, with search words e.g. cerebellum, stroke, rehabilitation, music therapy, therapy, rhythm. The search word stroke gave rich amount of articles. Based on my professional experiences with neurological patients I was willing to find material to open more the questions concerning impairments of the particular cerebellum stroke case. During the process the topics related to cerebellum stroke patient, like quality of movements, and working memory were brought up as essential to write out to explain the niche. Therefore, chapter for literature did grow fairly large. My interest for the assisting tools for the movements increased during the writing process. For me it was challenging to delimit the area discussed. Additionally it was problematic for me the definition of the framework.

My professional background played a role in this study and the research composed. It was aimed to explore the therapeutically process between the stroke patient and the music therapist instead of a physiotherapist. The in-depth experience of professional physiotherapist may have actually affected positive to the inspection of the study. One of the goals mentioned in the Curriculum 2010-2012 of Music Therapy Master's Degree Programme was that the student would be able to apply research findings in further development of music therapy as a profession and in interdisciplinary context (MMT Curriculum 2010). Thus, examining the current data in interdisciplinary context benefits every profession in the rehabilitation field. Therefore, the multidisciplinary approach seemed justified and relevant since no previous studies could be found in this particular subject and traditional music therapy approaches were not applicable without adaptation. Generally, according to Hirsjärvi et al. (2001), in any research the validity of the research and reliability of the results are evaluated during the process to assure scientific trustworthiness. In terms of qualitative research, reliability stands for the degree to which a study can be replicated and thus, its ability to produce consistent results. Validity refers to

the ability of methods or measurements to measure what they aim to do. (Hirsjärvi et al. 2001, p. 213.)

Every patient-therapist relationship and therapy process is unique. When two persons are working together in the therapeutically relation, they both are bringing their persons, life stories and ways of encounter emotions with them. It is problematic to evaluate the reliability in such case studies. How could it be possible that same methods of music therapy could be used with other patients and obtain the same results? "Music therapy is a transpersonal happening and what happens cannot be separated from the person of the therapist. Two therapists can apply the same therapy with quite different results" (Aldridge 1996, 104). The process described and evaluated in the study was unique and the way of working for the welfare of the patient was new for us both. The patient was informed of the new, potential strategy in the rehabilitation. We were building the frame for the process together. The common new target-orientated action stimulated and encouraged us. Perhaps this uniqueness could have influenced to the relationship between the patient and me. According to Aldridge the validity of this therapeutic "success" is open to question. "There may be a subjective bias influenced by the expectations of the therapist and the patient. Similarly, the patient may appear to improve through willingness to please the physician." (Aldridge 1996, p. 113.)

It could therefore be said that it is not possible to reproduce the same situation that occurs in one person in another person. Every therapist must start with the person as they are according to their individual biography. Each artistic work will develop out of this person's history and contribute to this history. Works of art taken out of the context of the patient, i.e. an individual being with a personal history located within relational and cultural context, lose their validity as phenomena. (Aldridge 1996, 104.) Second, my previous experiences of the topic music therapy were slender. Therefore I did improvise by creating the method used, in cooperation with the patient. The pictures made in the study are representing the tasks in the process. The pictures are exemplifying and facilitating the way of working considerably for the readers. I as the researcher tried my best in describing the process and my assumptions of the phenomenon thoroughly. As Aaltoila and Valli (2001) stated, despite the considerations explained earlier, in the qualitative research there is not to be found an inevitably rising truth, which could be stated as a result for the study. The researcher states his or her interpretation, a personal product of the phenomenon. The researcher shows the validity of the research by reporting of being conscious of the

alternation of gathering and administering the data. (Aaltoila and Valli 2001, p. 82.) In the remainder of this section, I evaluating my own role in the clinical process described in this study.

Some challenges faced in the therapy were as follows. First, the patient and me were the same age. I was very willing to find the best resources for rehabilitating the patient probably because of feeling the threat of the illness confronted so near to my self. However I did not find any disturbing issues by reason of this age question. I felt that I succeeded in maintaining the therapist's role while also being empathic towards the patient. Second, the early morning time for the therapy showed to be a challenge for me. In some mornings I felt difficult to start the session. I found my self not as creative as I would have been willing to be. The early time did not bother the patient. It was easy to activate him to work every time. The early time also enabled greater privacy for the therapy. The therapeutically work in the clinic started not until later in the mornings. The patient's concentration seemed to be disturbed by my colleagues in those few cases they interrupted our music therapy sessions. He seemed to need a calm environment. The sessions could not be conducted in a compact period, but did face a number of interruptions due to the therapist's becoming ill, the Christmas break, etc. The memory trace might have been stronger if the sessions had been closer together in time.

Some promoting factors included, first, the simple fact that my working room was excellent for the music therapy sessions. The soundproof room was peaceful. The singing and drumming on the table did not disturb the working of colleagues in the clinic. Second, the new way of rehabilitation interested the patient. His positive attitude for working was easy to observe. The environment was familiar to him, which decreased the extra tensions for the new working style. He seemed easy to accept his physiotherapist to work as his music therapist. I also managed to work around the fact that patient did not have any previous musical talents, that he could not play any instrument. It may have been more difficult for him to start such rhythm exercises, if he had musical skills like piano playing.

Some limitations of my own that may have adversely affected the therapy included the following. First, I found it challenging to try to see the rehabilitation world from a very different point of view after having worked as a physiotherapist for over 30 years. The same aspect, the large experience in the other profession has also made the clinical training so interesting. Second, I had some difficulties while considering the alternatives to

work with the rhythmical tasks. I was used to guide her patients verbally by motor performing. I came to notice that the amount of verbal direction used in guiding a patient with cerebellar stroke should be kept to a minimum. Many verbally orders may have confused the patient on occasion. Third, I had some problems based on my slender experience in assessing the tasks suitable for the patient. My background in understanding musical structures made it challenging for me to create the tasks suiting for the patient. I felt sometimes, that I had chosen too difficult ways of working for the patient. Fourth, I had reserved time for writing notes after every session. Although it often occurred, that I did not have the time to make notes immediately after the session. There may be forgotten some probably interesting thoughts of the notes. In the clinic it is impossible to avoid sudden interruptions such as telephone calls.

Some possible strengths of the therapist, on the other hand, include the fact that I thoroughly enjoyed the music therapy training time. The musical elements waked my interest for my work as a physiotherapist from another point of view. I have always been open to new experiences, and I felt able to employ my creativity in planning the music therapy sessions. Often the early planning was waste of work, because the occasions were changing and the way of working had to be change. As therapist I had to be ready for new ideas instead of those not succeeded. The therapeutically work is oriented to raise the level of the activeness in the impaired person. The therapist has to support the self-esteem and the mental resources of the patient in the rehabilitation process. Also, I felt I succeeded in winning the trust of the patient.

To work as music therapist has many similarities with the work as physiotherapist. In both professions the therapist has to create a confidential and inspiring relation with the patient. The open and encouraging attitude in the rehabilitation relation had created the fruitfully and positive cooperation between the patient and me. I discovered myself able to work with musical elements, even if I was not an artist, not a pianist nor a singer. I was also satisfied to notice that I successfully dealt with the problem of the patient's fatigue during the early sessions. Fatigue, tools to delete it, and the phases of the upper limb movements used in the tasks should be taking in consideration while planning exercises using rhythmical movements for stroke and other neurological patients.

Based on this study, I can certainly recommend that rehabilitation professionals adopt rhythmical exercises to contribute to their work with neurological patients. Therapists in rehabilitation are not keen to step over the limits of the other professions. Every therapist should estimate their own personal strengths and apply them choosing the most appropriate tools to work with the neurological patients.

Modern society demands rehabilitation for evidence-based practice. "At the same time as a practitioner is acquiring these new skills, she is forced to reexamine the status quo, the conventional wisdom of the rehabilitation professions. This combination of trying to learn new material while challenging previously held beliefs can engender frustration with the new material and doubt about previous learning" (Domholdt 2005, p. 4). Clinicians must balance the use of existing but unsubstantiated practices with critical evaluation of the knowledge of researches and literature. More discussion with colleagues is needed.

## **5.2 Some limitations of the study**

In hindsight, the main limitations of the study seem to me to be the following. First, I did have some problems with the structuring of the study: specifically, I found it difficult to inspect the study only from the viewpoint of music therapy. My background as a physiotherapist led me to inspect the issue perhaps larger than the case study report would have needed to. The data was collected a year before starting the thesis, whereas awareness that the data of the ten sessions would be used later would have led me to plan, prepare, and document the sessions in greater detail. The initial evaluations and assessments should have been more precise, and the study could have included more quantitative facts.

Consciousness of the efficiency of the therapy process inspected later in the study provided a great challenge for me throughout the research. By inspecting the process being so familiar for me, I may have passed over some relevant issues without writing them in observable form for the readers and myself. In the other hand I may have written too widely of the process experienced in my real world, not learned in literature. The study is discussing only the facts and phenomena in one case of cerebellar stroke patients. The important issues reported in the sub-chapter 4.2 were rising up in the music therapy

sessions of this particular patient. The findings may not appear by every cerebellar stroke patient. According to Aldridge (1996, p. 114), "a weakness of single-case designs is that, while individual change is specific, it is difficult to argue for a general validity of the treatment". This criticism may well apply to my own case also.

### 5.3 Conclusions

My most interesting trial to combine working methods of physiotherapy and music therapy started three years ago. The trial is written down, searched and estimated by me in this case study report. This is not an ordinary case report because of its broad literature review. The issue needed to be searched from a large point of view. With this study I wished to find the sakes influencing helping or disturbing the efficacy of the rehabilitation. I had realized the positive influence of the trial for the rehabilitation, but did not know why it had so inspiring effects for the rehabilitation process. That the researcher should not let the study to fulfill her prejudices, I am convinced about. I was willing to know more about the process.

The study reports of the components in the patients' ability of function that benefitted of the multisensory activation. The problems of the cerebellar stroke patient in the ability of function were difficulties in timing of movements, the speed, force, precision and allocation of them. The amount of repetitions of movements in rhythmical tasks were influencing for the increased quality of motor performing in the end of the process. The clumsy movements became more fluent. Also the improved motoric fluency was obvious in the speech of the patient. The working memory became largely activation with the series of rhythmically tasks. Without the thesis process I would not have noticed the important fact of working with upper limbs. The phases of the upper limb movements used in the tasks should be taking in consideration while planning exercises using rhythmical movements for stroke and other neurological patients. Specially, the important phenomena rose up in this study; fatigue and tools to delete it during the therapy session.

It is additionally pointed out in the study the psychologically activating factors in this way of working with the cerebellar stroke patient. The tasks proved interesting enough to invite

the patient to concentrate in exercises nearly 60 minutes sessions. The succeeded tasks and activities influenced patients' self-confidence and had an enormous efficacy for the outward appearance of him. According to the secretary of my physiotherapy practice the patient had like growing bigger and stronger during every session and the way of walking, the body language, showed more determination and confidence. The wife of the patient was very pleased of the increased multitasking ability of the patient. During their strolls he could discuss with the wife and observe the surrounding landscape. Before the music therapy process the patient was not able to concentrate in two simultaneous activities.

The qualitative research as a case report appears as an interesting and informative way to investigate rehabilitation events. Thus, there is a great need for measuring the results, for evidence-based information. The following studies concerning the procedures in rehabilitation of cerebellar stroke patients need more accurate pre and post measuring the ability of mentally and physically performances of the patient. Studies planed and conducted by multiprofessional researchers are needed.

Music and rhythm evokes various reactions, physically and mentally. Neurological patients, stroke patients benefit of activating stimuli for their motor performing. Therapist in the rehabilitation is needed to widen the tools he or she uses in the therapy for to help the patients from their stiff and reduced motor performing. It is important to point out that the process described in the study was carried out experimentally, with continuous improvisation. The curiosity for the project was great by both the therapist and the patient. The patient retained the positive attitude during the whole ten sessions. He did not even once refused to do exercises that often were not very "masculine". He was extremely convinced of the importance of the process. My experiences and findings in the clinical music therapy described in the study are reporting the real clinical work with real troubles, difficulties. But what is so best, they are reporting additionally of the positive, exhilarating moments in the rehabilitation.

#### **5.4           The patient's successful path to recovery**

The illness may change the direction of a person's life. That happened to Jussi, the man the same age with me. He got strokes in his cerebellum and had to face the life with several impairments, mental and physical. Our common working for his recovering started. I address my appreciation to him. He was willing to share his life; his struggles for gaining back his motor and cognitive abilities, the rehabilitation process with the readers of this study. His sense of humor and optimistic attitude made our common working fun and inspiring. It was easy to practice the work of music therapist with him. After the common process the patient has returned to working world, first for couple hours of days. He does not need any therapy and is working gradually longer days during the weeks.

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**APPENDIX 1****Description of the sessions****Structure of session 1 (29.10.2009)**

Prior studies have shown that stroke patients can modify the motor impairments when the motor system is directly influenced through the auditory system. The bulk of the first session was spent examining the structure of the chosen music while listening to it on CD, or while the therapist was singing Finnish songs or spelling lyrics of songs. She wanted to instruct the patient on understanding the concepts of rhythm, accent, and tempo.

The patient was sitting while listening to the music. The therapist tried together with the patient to find the rhythm and phrasing of the music and the lyrics, and to find appropriate accompanying bodily movements. For the first session the therapist had chosen traditional Irish folk music, which had a march-like rhythm. While listening together, the therapist tapped the table on the rhythm of marching music and counted to him the number of accents. She wanted to help the patient to realize that the phrases in that music mostly consisted of 8 accents. The same 8 count phrases exist also in lyrics of songs. It is possible to find the 8 accents ensemble, phrases also in traditional Finnish folksongs. These 8 accents ensembles seemed to be very natural in singing, giving natural pauses for breathing.

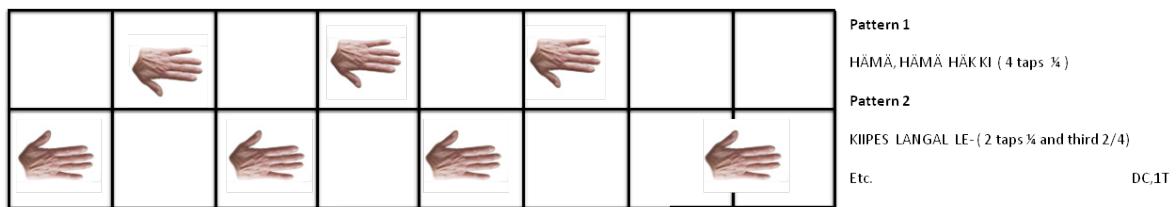
The therapist and the patient also explored some music in 3/4 time, namely waltzes. The patient found it easy to do the swinging smooth tempo in his movements while still seated.

*Hämä, hämähäkki*

The itsy-bitsy spider went HÄMÄ, HÄMÄHÄKKI  
 up the water spout KIIPES LANGALLE  
 Down came the rain and TULI SADE RANKKA  
 washed the spider out HÄMÄHÄKIN VEI  
 Out came the sun and AURINKO ARMAS  
 dried up all the rain, and the KUIVAS SATEHEN  
 itsy-bitsy spider HÄMÄ, HÄMÄHÄKKI  
 went up the spout again KIIPES UUDELLEEN

## Task 1

In the beginning it seemed challenging for the patient to tap the table with each hand, rhythmically one after another, simultaneously speaking the lyrics with me. The therapist was giving him the auditive activation and tempo by speaking with him the lyrics of *Hämähäkki*, pronouncing with moderate tempo the syllables (4/4 steady beat).



Picture 11: Task 1

## Structure of session 2 (4.11.2009)

The session was started with discussion of experiences from the first session. The patient found the session very interesting. He had trained those exercises at home and filmed them on video. He likes to inspect his walking and moving visually by video. He wanted to show the therapist these videos, but the battery of the video camera was empty in that session time.

## Task 2

As the starting exercise we were listening to Irish march music ("It's a long way to Tipperary"). The therapist and the patient counted together 8 accents phrases, which they then tried to find in marching. They were marching 16 steps forwards, 16 steps backwards etc. The therapist was marching beside the patient so that he could see her on his side and on the mirror as well. The therapist informed him on the 14. step to prepare for changing the direction of marching.

### Notes:

- The waltz music was more difficult for the patient to listen and to feel it in his body.
- The therapist and patient made a trial to step up from the chair and back down in the rhythm of an Irish waltz.

- This exercise was too difficult for him.

#### **Video clip 1. (00:00:20)** (similar to task 1 in session 1):

- The exercise is described in the session 1 as a task 1.
- The exercise was repeated twice until the patient succeeded to do it by himself, without therapist's voice as auditory support.

Notes:

- The tapping was regular, but there were more power used, than necessary.
- He was speaking in a steady, level voice, no mix-ups.

#### **Task 3**

#### **Video clip 2. (00:00:18)**

- Instead of tapping with hands, the patient was stamping his feet rhythmically while sitting on a chair. This seemed to be easier for him than the first exercise.
- In the video clip it was only the therapist, who was speaking, reading the lyrics. The video clip does not show the patient's face. He looked very intensive at his feet while stamping.
- The ankles and toes seemed to be relaxed. The concentration on movements was better, when he was only stamping and not speaking simultaneously.

#### **Task 4**

#### **Video clip 3. (00:00:41)**

The therapist started to modify exercises. The song was the same as previous;



Picture 12: Task 4

The patient tried to tap four taps each with the right hand, and then four times with the left hand and then forward similarly.

First the therapist counted together with the patient 1,2,3,4 in a clear voice and he tapped relative regularly 4 times on the table with the right hand (RH). The similarly tapping with the left hand (LH).

00:00:07 The therapist started to read the rhyme (not counting), but the patient continuously counted 1,2,3,4. The taps of RH went well, but then with 2.tap of LH came RH also with. The patient let it fall down, but with the 4.tap of LH the RH rose again and stayed up. It came late down and LH tapped once too much (5 taps).

TULI SADE RANK- KA = 4 taps with R, but they were not regular and there came one tap too much.

HÄMÄ- HÄKIN VEI - =4 taps with LH. Taps were unregularly, and they were 5.

00:00:18 The patient lost the really control of hands. After AU, the therapist stopped tapping. The whole time the patient had counted 1,2,3,4, but he had difficulties to find right numbers. The therapist told him to start from beginning again.

HÄMÄ, HÄMÄ-, HÄK- KI (RH 4 taps) KIIPES LANGAL- LE - (LH 4 taps)

TULI SADE RANK- KA (RH4 taps) HÄMÄ- HÄKIN VEI - (LH 4 taps)

AU- RINKO AR- MAS (RH4 taps) KUIVAS SATE- HEN - (LH 4 taps)

Tapping was regular (very slightly unregularly) and the patient still counted himself.

00:00:34 HÄMÄ HÄMÄ- HÄK- KI=, the rhythm braked again, his RH tapped 5 times unregularly.

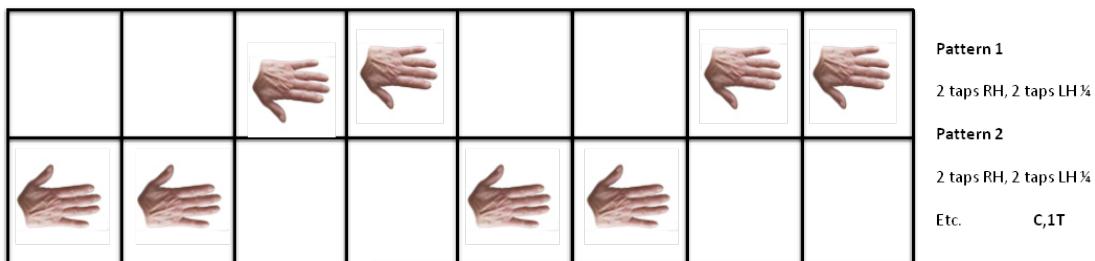
KIIPES UUDEL- LEEN=, his LH found not the rhythm any more. The patient's counting was unclear.

00:00:41 the video clip was stopped.

## Task 5

### Video clip 4. (00:00:15)

This preparing exercise was done for to learn the double tap. The patient was allowed to concentrate only on tapping and the therapist was counting aloud one, two, one, two etc.



Picture 13: Task 5

The two first taps went correctly, but then the patient tapped with his LH only once. He continued again 1,2 (RH) and 1 (LH).

00:00:07 the therapist asked him to stop and start again. He continued like he had started. He did not change tapping.

After noticing, that the patient's working memory does not accept any more new models of acting; the therapist rejected the exercise for a while. His capability to concentrate on this kind of working was low.

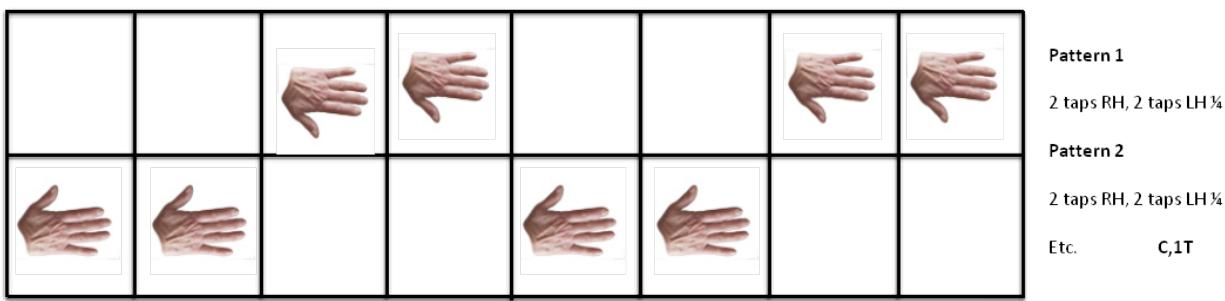
### ***First Exercise to Prevent Fatigue, Brain rebooting***

The patient was guided by the therapist to move on the trampoline and jump on it for couple minutes. After jumping, he was again ready to face challenge for intelligence.

The task 5 was repeated.

### Video clip 5. (00:00:23)

Task 5 repeated:



Picture 14: Task 5 repeated after the fatigue preventing exercise

The patient was tapping, and the therapist spoke the rhyme, lyrics. In this exercise he had to tap twice with each hand: HÄMÄ, HÄMÄ (RH 2 taps), HÄK- KI (LH 2 taps) etc.

00:00:15    KUIVAS SATE- (RH 2 taps) slightly unregularly,  
 by -HEN syllable was the tap unsure, and the patient began to chuckle.  
 HÄMÄ HÄMÄ- HÄK- (RH involuntary 3 taps),  
 -KI, KIIPES UUDEL- (LH involuntary 3 taps) LEEN (RH 1 tap)

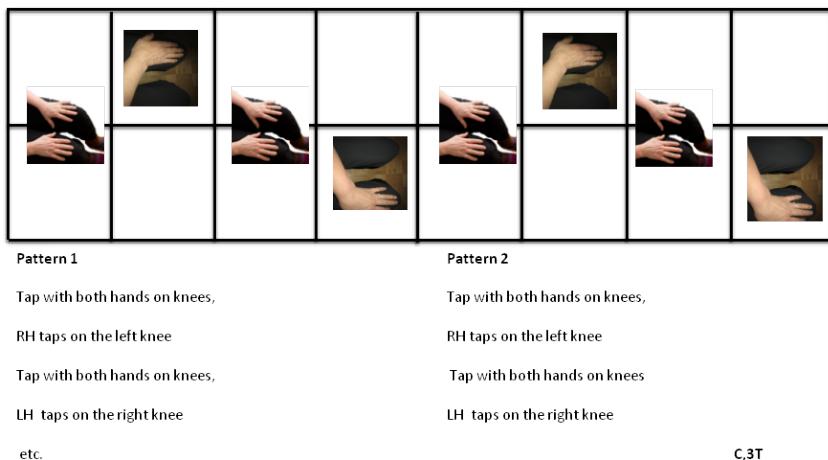
Notes:

- The patient had made big efforts with these exercises.
- It was amazing, how well he made the exercise on the video clip 5, after he had jumped on the trampoline!

## Task 6

In the end of the session there was made a new tapping exercise.

With Irish marching music on the background the patient and the therapist tapped (4/4 steady beat):



Picture 15: Task 6

Notes: This seemed to be very easy for the patient.

### Structure of session 3 (30.11.2009)

#### A warmup activity (repeated the task 2)

The patient and therapist started (as a warmup exercise) with marching the phrases of music (16 steps) forwards, to right side, backwards, and to left side etc. Marching was done on the spot, with music on the background, moving arms in broad circular motions.

#### Waltz music: Movements with the $\frac{3}{4}$ beat

The patient and the therapist were standing in front of mirror. The therapist was as lead of movements for him.

- The therapist guided the patient to listen the measure 1,2,3(1pattern) of the music. In that tempo they changed weight from the left leg to right leg etc.
- Standing on the left leg, swinging the right leg back- and forwards the time of one phrase (8 measures). Continuing with the other pair etc.
- Same kind movements with waltz music, but swinging the leg to side and crossing the standing leg.
- Standing and moving the arms back- and forwards
- Standing and moving the arms to side and crossing arms in front of body

- The therapist and the patient were standing face to face and he tapped the therapist's left hand with his left hand concentrating to tap on the first 1/4 of 3/4. The next 1/4 he tapped it with the opposite arms etc.

### **March music: Movements with the 4/4 beat**

The therapist and the therapist were listening march music on the CD (Irish march music) and sitting face to face.

- The patient tried to hear the phrases in the music and to indicate the starting moment of a new phrase by lifting his arm up. It seemed to be easy for him. He did it correctly and he was very proud of himself.
- Because the patient performed the previous exercise so fluently, the therapist asked him to clap the hands together on the first accents of phrases. He succeeded in that as well.

### **Repeating tasks 1 and 5**

The therapist was reciting “**Hämä, hämähäkki**” (tasks 1 and 5, described previously).

The patient tapped table like on the previous session.

Notes:

- Single taps were easy.
- Double taps seemed to be difficult. It was obvious, that the patient was too tired for this kind of mental work.
- 

### **Second exercise , Brain rebooting**

Because of tiredness for rhythm exercises, the therapist offered for the patient a task for arranging numbers 1-36 in a certain order in 36-box square (writing numbers). This was a new challenge for him and he was very interested.

### **Repeating again task 5**

After the previous task the patient was energetic again, and repeated task 5.

Notes: It went perfectly, with no mistakes.

- The patient was in a good mood in the whole session. He was surprised of hearing correctly the phrases. He had thought, that he does not have “ear for music”.
- The patient clearly needed something else in between, so that the brain could have possibility to activate the other parts also, to renew activation.

### **Structure of session 4 (4.12.2009)**

The session started with discussion about feelings, mood, and happenings from last days. The patient said his legs were tired this morning, but that mentally he was very well and good mood. The therapist felt herself very tired because of the dark mornings, because of need for bright days. Jussi mentioned to be still interested of the music therapy project, that he still has a positive attitude.

#### **Warmup activity (task 2):**

For warmup the body and mind Jussi and the therapist walked and marched with Irish march music on the background from a CD. They changed the style of moving with the phrases of music.

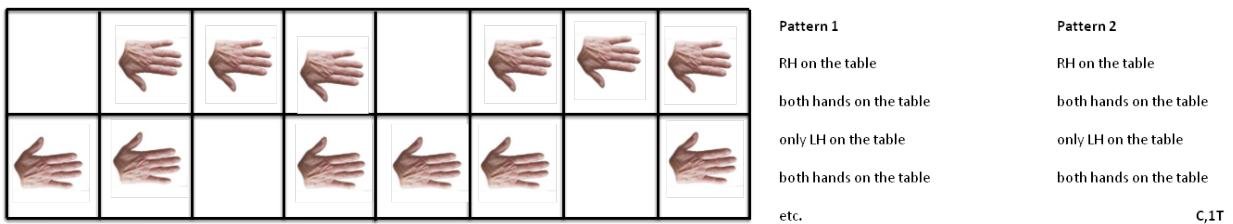
For the next tapping task the therapist gave the tempo by singing “Hämä, hämähäkki” or “Yksi pienielefanti”. The patient and the therapist were sitting face to face, the therapist on the other side of the table and tapping along with the patient.

**Task 1** Single taps 1/4

**Task 5** Double taps 1/4

#### **Task 7**

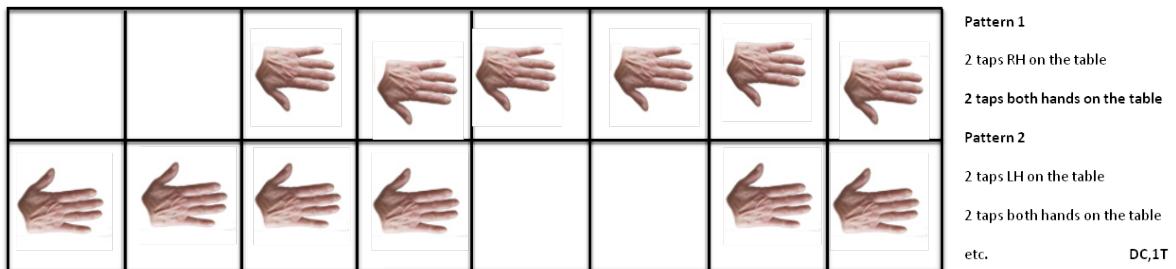
Each tap (1/4)



Picture 16: Task 7

### Task 7, variations 1

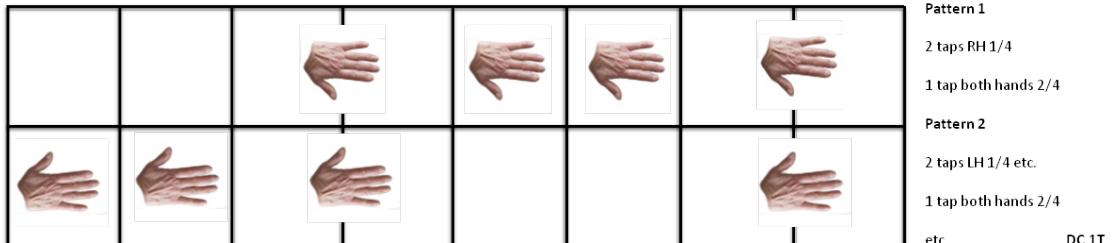
Double tapping, each tap 1/4



Picture 17: Task 7, variation 1

### Task 8

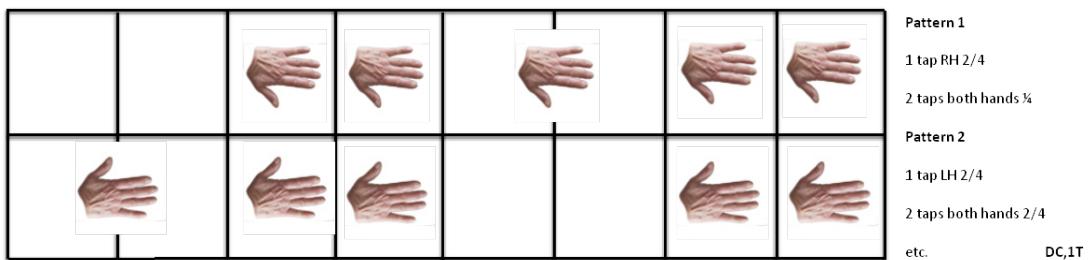
The duration of taps: 1/4, 2/4



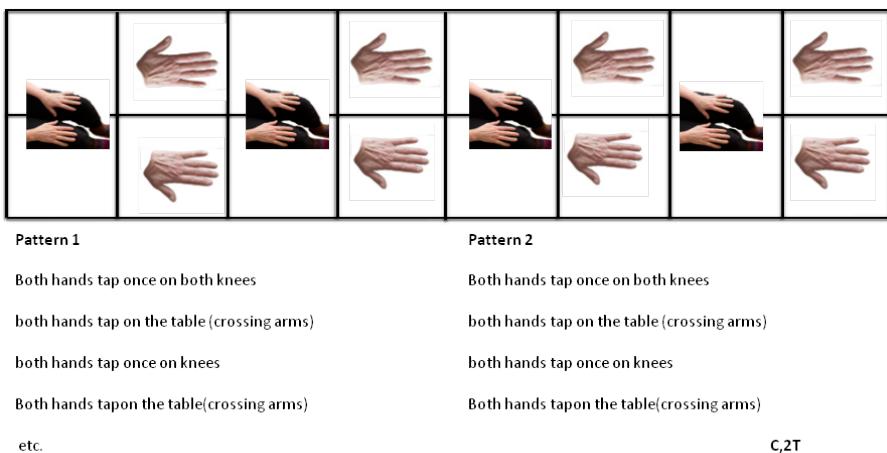
Picture 18: Task 8

### Task 8 variation 1

The duration of taps: 1/4, 2/4



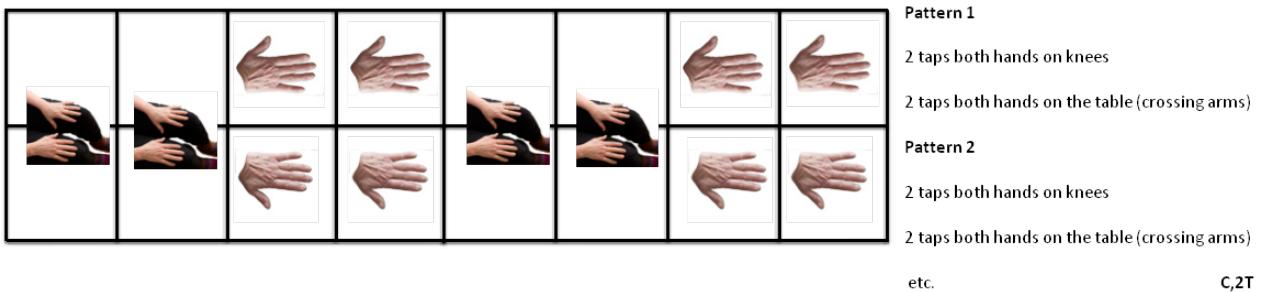
Picture 19: Task 8, variation 1

**Task 9**The duration of taps  $\frac{1}{4}$ 

Picture 20: Task 9

**Task 9 variation 1**

Duration of taps 1/4



Picture 21: Task 9, variation 1

## Task 10

Duration of taps 1/4


### Pattern 1

RH taps on the right knee

LH taps on the left knee

2 claps hands together in the middle line

etc.

### Pattern 2

RH taps on the right knee

LH taps on the left knee

2 claps hands together in the middle line

C,3T

Picture 22: Task 10

## Task 10 variation 1

Duration of taps 1/4, 2/4


### Pattern 1

1 tap RH on the right knee,  $\frac{1}{4}$

1 tap LH on the left knee,  $\frac{1}{4}$

hands together in the middle line, 2/4

etc.

### Pattern 2

1 tap RH on the right knee,  $\frac{1}{4}$

1 tap LH on the left knee,  $\frac{1}{4}$

hands together in the middle line, 2/4

C,3T

Picture 23: Task 10, variartion 1

## Task 11

Duration of taps  $\frac{1}{4}$


### Pattern 1

both hands tap on both knees,  $\frac{1}{4}$

hands together in the middle line,  $\frac{1}{4}$

both hands tap on the table,  $\frac{1}{4}$

hands together in the middle line,  $\frac{1}{4}$

etc.

### Pattern 2

both hands tap on both knees,  $\frac{1}{4}$

hands together in the middle line,  $\frac{1}{4}$

both hands tap on the table,  $\frac{1}{4}$

hands together in the middle line,  $\frac{1}{4}$

C,3T

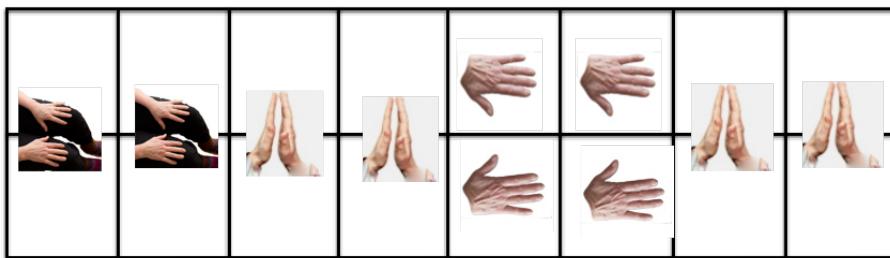
Picture 24: Task 11

## Task 11 variation 1

Task 11 + in addition, the patient was sitting down and marching with legs simultaneously paced with hands.

## Task 11 var. 2

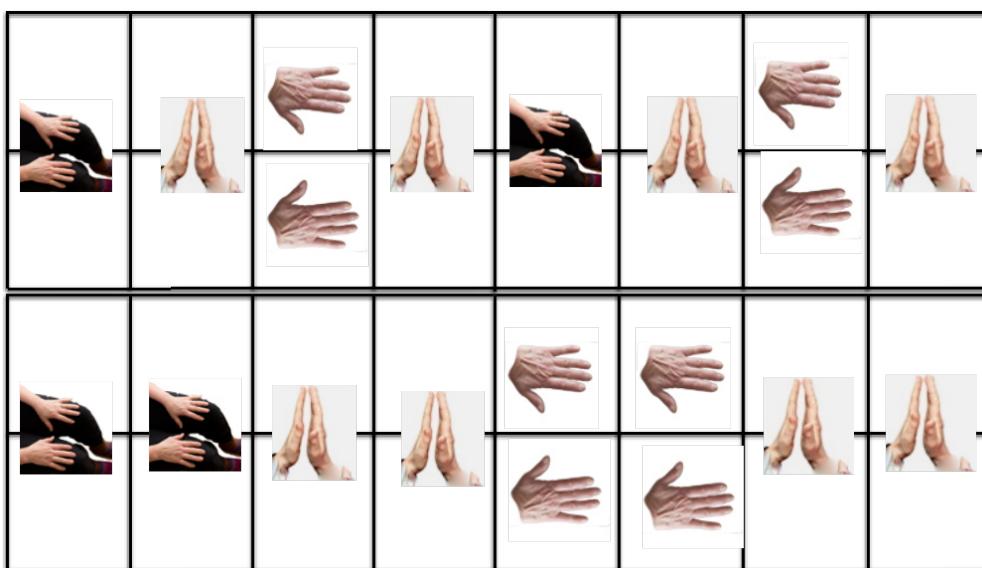
Similar to task 11, but every hit doubled, duration of taps  $\frac{1}{4}$ .



Picture 25: Task 11, variation 2

**Task 11(during 8 accents) + task 11 var. 2 (during 8 accents)**

As a last, an extreme demanding, version of the task 11, the patient had to mark out phrases by changing the pattern of tapping.



Picture 26: Task 11 and variation 2 combined together

Notes:

- This session was amazing. Jussi was able to concentrate the whole session.
- He was listening very careful the singing of therapist and looking also the movements of the therapist.
- Even though the whole session was only tapping and clapping, the patient Jussi did not lose his intensity for working.
- They both found the session successful.
-

## Structure of session 5 (7.12.2012)

### A Warmup activity

Changing the style of movements along the phrases

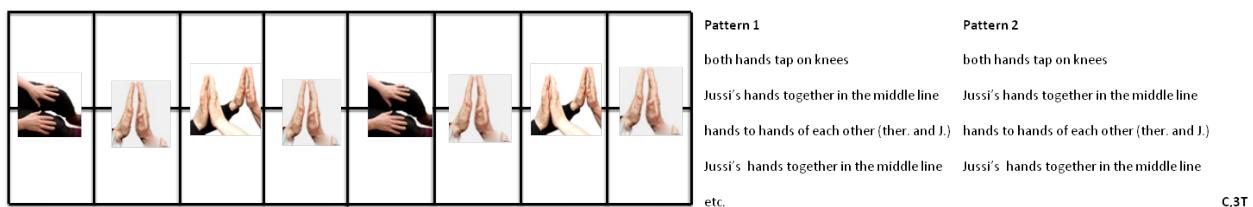
The session started with warmup activities. For warmup the body and mind the patient and the therapist walked and marched with march music on the background from a CD. They changed the style of moving along the phrases of music: one phrase long **walking**, one phrase long **marching on tiptoes on one place** etc.

Marching **sideways**, to left and to right along the phrases of music.

### Task 12

March music on the background the therapist and Jussi are standing face to face.

Duration of taps 1/4



Picture 27: Task 12

### Relaxation exercise

The patient was lying on the mattress. As a background music was selected a pan-flute music. The therapist was sitting behind the patient's head. The therapist instructed him to breath deep and to let the chest expand with the breathing. He was told to slow down the breathing density. The therapist guided the patient to imagine a hot, bright light ball to warm up first his toes, legs, then his pelvis, back, neck, arms, fingers, and head. He was told to relax while feeling the warmth in the body. The therapist invited the patient to imagine to lie in some lovely place on the beach, listening the water sound and birds etc. After 5 minutes relaxation, the therapist invited him back to the real world, to his real body, to open fingers, to move his own toes. Little by little he opened eyes.

The patient told he had found it relaxing, and had felt his body to be smooth and heavy. He said he had heard the birds and that he had been sitting on the beach of his summerhouse.

### **Hämä, hämähäkki- tapping exercise**

The last part of the session was the tapping part. The patient was sitting on the other side of the table and the therapist on the other side, face to face to him. The rhyme was again “Hämä, hämähäkki”. Either the therapist alone, or both the patient and therapist read the rhyme. They were repeating some of the previous tapping exercises, beginning from the easiest one in direction to those more demanding tasks.

### **Repetition of the task 8 variation 2**

Duration of taps 1/4, 2/4

								Pattern 1	Pattern 2
								RH taps on the table 2/4 LH taps twice on the table 1/4 RH taps on the table 2/4 LH taps twice on the table 1/4 etc.	RH taps on the table 2/4 LH taps twice on the table 1/4 RH taps on the table 2/4 LH taps twice on the table 1/4 C,1T

Picture 28: Repetition of the task 8, variation 2

The patient made same task again, but with the opposite hand. This task seemed to be too charging, but the patient wanted to repeat it many times, till he succeeded. He was not willing to give up. It was nice to leave the exercise with succeeded feeling.

### **Relaxation Exercise**

For relaxation exercise the patient and the therapist were stretching themselves in standing position, the Pan-flute music on the background. The patient was instructed to concentrate in slowing down his breathing tempo and to extend the time of breathing out.

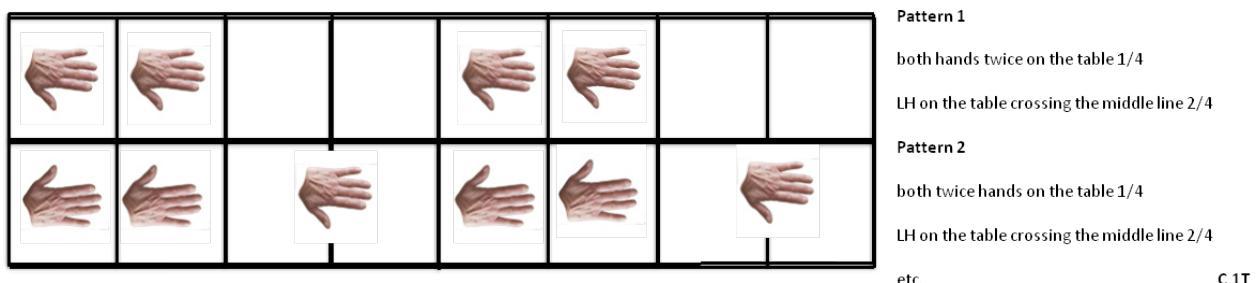
## Structure of session 6 (7.1.2010)

### A Warmup activity

The session started with warmup activities. To warm up the body and mind, the patient and therapist walked and marched with march music on the background from a CD. The patient and the therapist were repeating **the task 8 variation 2** without any difficulties.

### Task 13

Duration of taps 1/4, 2/4



Picture 29: Task 13

### Video clip 6. (00:00:10) (Task 13)

This video clip shows, how patient succeeded in the task 13: the therapist and the patient both were reciting “Hämä, hämähäkki” rhyme.

00:00:05 After having done the exercise once through, the patient forgot to leave the RH on its place. The patient tapped with RH simultaneously while LH came crossing the middle line. He noticed it, and turned his head toward the therapist and camera. Still he tried to continue two seconds, but then he stopped.

### Video clip 7. (00:00:21) (Task 13)

This video clip shows the new trial of the **task 13**. The patient tried the tapping first without the rhyme on the background.

00:00:05 He started to tap. The movements were not well coordinated. Timing of movements was not exact. Especially, the RH was late in every trial in crossing the middle line. The tapping with LH was inexact. Even though this tapping surely was difficult for the patient, he continued tapping. He did not lose his temper.

### **Video clip 8. (00:00:15) shows the third trial of task 13.**

In this case the therapist was sitting on the other side of the table, face to face the patient. **She was tapping and reciting the rhyme with** the patient (The therapist stopped the speaking at 00:00:06, because the patient seemed to manage alone). The tempo was now higher than in the previous trials. The movements were exact and well coordinated. The patient's voice and pronouncing was clear.

The therapist and patient were sitting like in the previous exercise. The Irish march music was in the background. He and the therapist together tapped **the task 11**. It went well and without difficulties.

### **Task 14**

Duration of taps  $\frac{1}{4}$ , tapping a longer sequence:



Pattern 1	Pattern 2
both hands on both knees	both hands on both knees
hands together in the middle line	hands together in the middle line
RH on the right knee	LH on the left knee
hands together in the middle line	hands together in the middle line
etc.	DC,4T

Picture 30: Task 14

Notes:

- This went amazingly well without difficulties. The patient concentrated well all the time.

### **March music – Tapping Exercises**

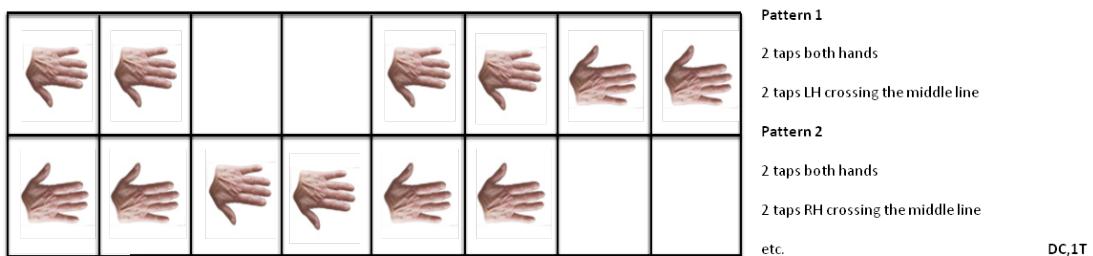
The therapist and the patient were sitting as in the previous exercise. The Irish march music was in the background. The therapist was giving a simple tapping model and the

patient was following her. The therapist changed the model and again he managed to follow her.

The therapist and the patient were changing the roles. He gave the tapping model and the therapist tried to follow him. He even guided the therapist to tap doubled on the table and doubled tapping cross the middle line:

### ***Task 13 The patient's variation (variation 3)***

Duration of taps 1/4



Picture 31: Task 13, the patient's variation

Notes:

- This all went well and they both really enjoyed the game.
- In the end of the tapping part the patient's and the therapist made the exercise, in which they connected **the task 8 +** in addition, the patient was sitting down and marching with legs simultaneously paced with hands. When hands were **tapping doubled** then legs also.
- The movements were fluent and exact and the game was enjoyable.
- The patient was playing, working intensively. He was slightly impatient to listen all orders before he started to work. That was his difficulty in the whole process.

### ***Marching on step boards: steady beat 4/4***

The therapist gave four step boards to the patient on the floor. The patient should put them in proper distance of each other, so that he is able to march on every board and take one step in between every board while he is moving sideways. The therapist was giving the rhythm with singing melody of "Kalle-Kustaan muori" (kind of march music).

Marching 16 steps sideways (= 8 measures) the left foot was leading. After these steps (this phrase) the patient changed direction. Now the right foot was leading 16 steps. He was asked to clap his hands together on the last step of each phrase. The therapist helped him by showing the place of clapping. He seemed to enjoy this kind of activity.

### **Structure of session 7 (4.2.2012)**

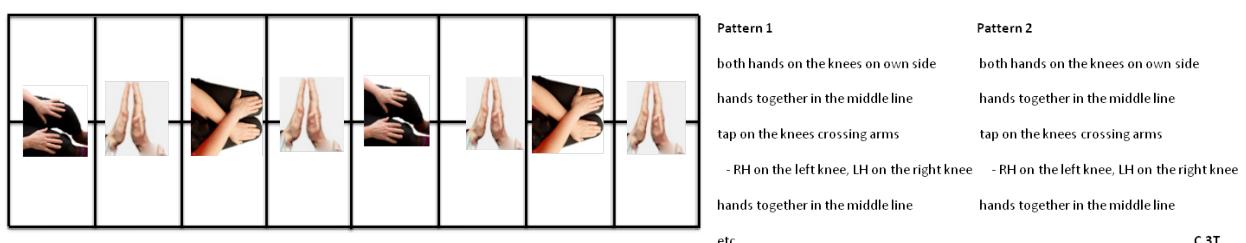
The session started with warmup activities with a steady beat of 4/4. For warmup the body and mind Jussi and the therapist walked and to music. The music of Irwin Goodman was pop-music, but the rhythm was suitable for marching: “Po, po, po, poing” (kind of march music). This music was familiar for Jussi from his youth. While marching Jussi and the therapist changed the way of moving along the phrases.

### **Hämä, hämähäkki – tapping exercises (repeating tasks 9 and 10)**

The patient and the therapist repeated the previous tasks 9 and 10 and their variations simultaneously reciting the rhyme “Hämä, hämähäkki”. It was fluent and without mistakes.

#### **Task 15**

Duration of taps 1/4, march music on the background. The patient and the therapist were sitting face to face.



Picture 32: Task 15

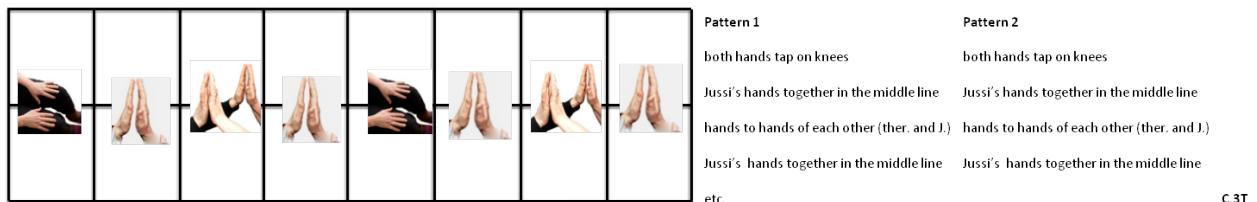
Notes:

- This seemed to be quite difficult to the patient.
- It was repeated several times for to have it done without mistakes.

## Repetition of task 12

Without music, standing face to face, the patient and the therapist practiced task 12.

Duration of taps  $\frac{1}{4}$ .



Picture 33: Repetition of the Task 12 without music

### ***Repetition Task 12, Variation 1 with music***

With music on the background, sitting. When this task 12 was succeeded well, after repeated many times, this same exercise was done to the rhythm of “Po, po, po, poing” of Irwin Goodman (kind of march music, steady beat 4/4). The patient and the therapist were sitting face to face. To sit gave the patient a better opportunity to concentrate on the task (did not need to hold the balance while tapping).

### ***Repetition Task 12 Variation 2 with music and marching***

This was done also standing while stepping on place (marching) and tapping like task 12.

### ***Repetition Task 12 the patient's variations***

The patient wanted to try also his own ideas of tapping with the music. The trials were short and they were variations of previous exercises.

### **Tapping Exercises in order of “Rudiments”**

Order of the hands	= Right hand
	= Left hand
1.	
6.	
2.	
7.	
3.	
8.	
4.	
9.	
5.	
10.	

Picture 34: Rudiments

**Rud. 1-4** Tapping hands on the table, based on tapping-map, written orders. The patient was counting aloud simultaneously from 1-4. This seemed to be easy for the patient. The voice was clear and the numbers were correct all the time.

**Rud. 5-6** In tasks 5 and 6 the patient wanted to count the single tap as the first and the next three taps with other hand as second, third and forth taps. He said, that like this it would be much easier.

#### **Rud. 7-10**

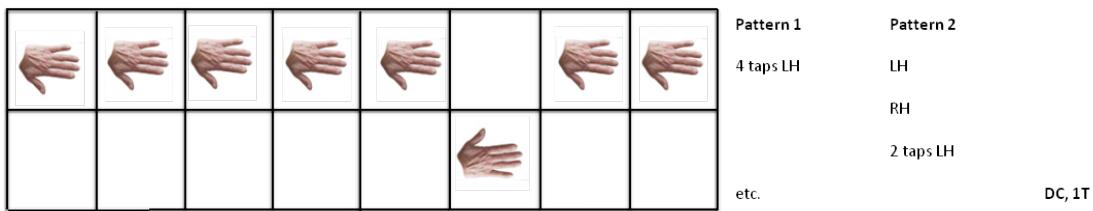
The patient did tasks 7-10 without difficulties.

#### **Rud. 6+8, 5+7**

Also combining of tasks 6 to 8 and 5 to 7 were done well by the patient.

#### **Rud. 7+9, 8+10**

More complicated and challenging were the tasks, where the tasks 7 and 9 were combined together and tasks 8 and 10 were combined together. The combining of two tasks forms an ensemble of 8 count, like in every previous exercises there was used ensembles of 8 counts = one phrase. But in none of those previous tasks was the tapping done like this, in odd number of tappings:



Picture 35: Rudiments 8+10



Picture 36: Rudiments 7+9

#### Notes:

- This was very demanding for the patient. He tapped in very slow tempo, many interruptions. The therapist interrupted the exercise, as she noticed, that the patient was too strained.

Like in previous sessions, when the patient was too strained, the therapist offered him some very different task in between.

#### ***Third exercise to prevent fatigue (between tasks)***

As a task of variety the therapist asked the patient to draw 4 circles with his right hand on the surface of the table and then 4 circles with his left hand. The drawing happened in the lazy rhythm of Irving Goodman music, which the therapist was slowly singing.

#### **Repetition of the Rud. 7+9 and 8+10**

After this relaxing pause the therapist asked the patient to repeat with her the previous, difficult exercise (combined 7+9, and 8+10). In this case the exercise did not anymore seem to be difficult for the patient.

The combining the legs to stump in the rhythm of tapping hands (simultaneously RH and right leg, LH and left leg) was not too difficult to the patient. He could do it without difficulties.

The therapist enjoyed of the patient's activity to make his own solution in tapping tasks **rud. 5 and 6**. The patient showed own interest and activity. The atmosphere was positive and the patient was working very well and concentrated. If he made a mistake, he only sneered and started over again.

### **Structure of session 8 (11.2.2010)**

#### **A Warmup activity**

The session started with warmup activity. For warmup the body and mind the patient and the therapist walked marching with Irish marching music on the background from a CD.

#### **Activations in phrases of 8 accents**

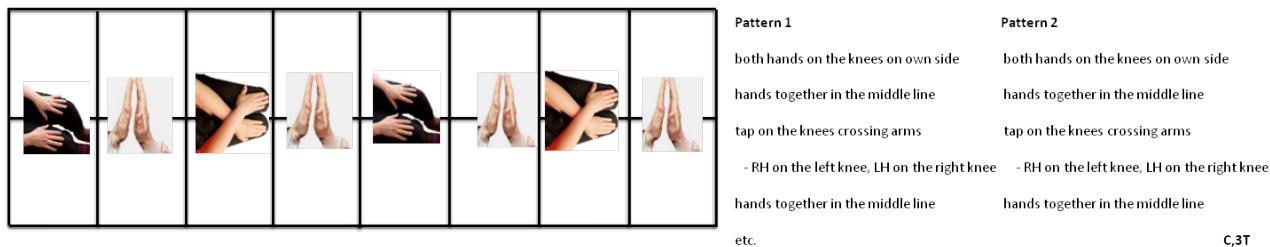
- The patient and the therapist were **marching** (without moving from the place) and **lifted their knees up** on every step. On the next phrase of music they stopped the stepping and lifted themselves to stand **on toes** in the rhythm of music etc.
- The therapist had chosen a piece of Irwin Goodman, "Hurraa me tehdään laivoja" for the background music.
- The piece comprised of two parts; **Part A** is 4/4 pop music, the **part B** is very strict, strong march music. While the part A is playing, The patient and the therapist **lifted one-kilo weights up to straight arms** in the rhythm of music.
- While the **part B**(also steady beat 4/4, but very different from part A) was playing, The patient and the therapist were **marching 8 steps forward and 8 steps backwards** etc.
- The patient seemed to hear well, when the parts were changing, but always he was late a bit on starting a new action.

#### **Hämä, hämähäkki – Tapping exercise**

The patient and the therapist were sitting face to face. They repeated previous **tasks 9 and 10** simultaneously reciting the rhyme “Hämä, hämähäkki”. It was fluent and without mistakes.

## **Repetition of task 15**

The patient and the therapist were sitting face to face. Duration of taps  $\frac{1}{4}$ .



Picture 37: Repetition of task 15

In this exercise the patient seemed to have difficulties again, like also in the last session. He did not remember, where he should tap next. The patient tried to help himself by speaking to himself the plan, in advance, explaining what should be done. He was in good mood, not getting nervous, laughing at mistakes. In this session he **only once** forgot the last instructions and started to do on based of the previous instruction, what the therapist had asked him to do.

The therapist interrupted the exercise, as she noticed, that the patient was too strained.

### ***Fourth exercise to prevent fatigue (between tasks)***

Like in previous sessions, when the patient was too strained, the therapist offered him some very different task in between. The therapist asked the patient to "draw" circles with his hands on the surface of the table. He did it circa 10 times and then he changed the direction of "drawing" circles.

After this pause for recreation the patient was able to do **the task 15** (Picture 37, see above) without difficulties.

The patient repeated from session 6, **exercise with step-boards**. The therapist sang marching music “Kalle-Kustaan muori makaa hiljaa haudassaan” on the background.

The most difficult part in this exercise was the **changing direction of marching**. This part of exercise was then repeated many times. The patient liked this marching a lot.

## **Exercises with step boards**

### **Video clip 9. (00:00:23)**

- After the first phrase (08 sec) the therapist gave the clap example, The patient did not find it himself. Moving was in the right tempo, and movements seemed natural and easy.
- In the second phrase (08 sec) (moving sideways to right) movements were fluent as well. The patient found himself the clap on the last step!!!
- Also the third phrase the tempo of the steps was equal (08 sec), but the therapist was careless, and stopped the camera before The patient clapped hands together.

#### Notes:

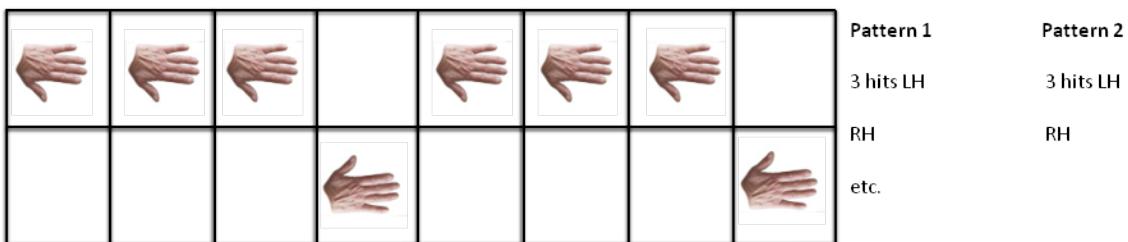
- The patient realized, that he has learned to listen the phrases of the music. He was very pleased, the therapist as well!! Especially the patient enjoined of the lucky placed clapping.

The therapist had made tapping plans, **drawn rudiments** (of previous session) on the paper. The patient read them and simultaneously tapped those tasks, **rud.1** and **rud.3**. He did not have any difficulties.

### **Video clip 10. (00:00:22) rud. 6**

(3 taps with LH, 1 tap with RH etc.)

The therapist sang on the background in a steady beat “Kolme pientä elefanttia marssi näin”. The patient tried to start by tapping 2 taps with LH instead of 3 taps. He did it twice. He noticed it and stopped.



Picture 38: Rudiment 6

The patient started again correctly at 00:00:08 and he simultaneously counted aloud from 1 to 4 while tapping.

00:00:19 After 3 LH tapping the patient did not find the next RH work. He stopped to think and then he continued the task to the end.

### Video clip 11. (00:00:10) rud. 5

(3 taps with RH, 1 tap with LH etc.)

The therapist sang on the background in a steady beat "Kolme pientä elefanttia marssi näin". The patient was counting aloud from 1 to 4 while tapping. He held the steady beat in tapping.

00:00:05 the LH tap was a bit late. In the last part, the patient tapped only 2 taps with RH and stopped the verse nicely to LH tap.

### Video clip 12. (00:00:17), combination of rud. 7 and 9

(7 = 4 taps RH, 9 = 1 tap RH, 1 tap LH, 2 taps RH, etc.)

The drawn rudiment was on the table visible to the patient. The therapist counted aloud with the patient the taps from 1 to 4. The patient had difficulties in starting. He started again at 00:00:02. The patient seemed to be so concentrated in counting and in the work of RH, he forgot the LH on his lap. The LH was every time late. The beat was not steady.

The patient was very unsure of every change of hands. He tapped 3 times tasks 7and 9. He could not count aloud clear, only mumbling with a small voice.

### Video clip 13. (00:00:17), combination of rud. 8 and 10

( 8=4 taps LH, 10 = 2 taps LH, 1 tap RH, 1 tap LH, etc.)

The drawn rudiments were on the table visible to the patient. The therapist counted aloud with the patient the taps from 1 to 4.

The patient tapped the rudiments two times and then stopped, but the therapist asked him to continue. He still tapped once again. The RH was actively with the work, not in the lap. But tapping was late all the time. The patient was very unsure in this task. The voice of the patient was clearer than in the previous video clip.

The drawn rudiments were on the table visible to the patient. The therapist discovered to help the patient's work by guiding the "notes" with a pencil. In the task was changed the order. First was placed task 8 and after it 10 etc. The therapist and also the patient sang the song "Kalle-Kustaan muori makaa hiljaan haudassaan".

#### **Video clip 14. (00:00:19), combination of rud. 8 and 10 and a pencil**

This combination was played 4 times in 19 seconds. The therapist helped the patient's work by guiding the "notes" with a pencil. He tapped without interruptions. The beat was not exactly steady, but fluent.

The patient was singing with in the beginning, but after couple seconds he stopped singing and continued with mumbling.

#### **Structure of session 9 (2.3.2010)**

##### **A Warmup activity (task 2)**

The session started with warmup activitys. For warmup the body and mind the patient and the therapist walked marching. The CD-player did not worked, so the therapist had to sing on the background. ("Kalle-Kustaan muori makaa hiljaan haudassaan..")

##### **Drumming with buckets**

Because the therapist did not have drums in the physiotherapy local, the therapist decided to use buckets as drums. The patient was sitting on a stool and the buckets were standing upside down in front of him on the table. The patient got mallets in his hand.

The therapist wanted to start with very easy drumming tasks. The patient seemed to have the mallets very naturally in his hands. He found easy the way of hitting the “drums”.

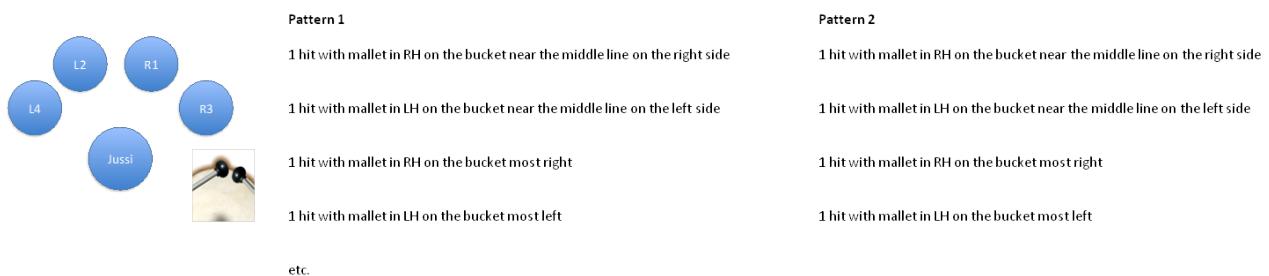
The therapist had an idea that drumming like mirroring hands, would be the easiest way to start with **Task 16**

Four buckets upside down on the table in the form of slight arc. One hit on every bucket.

The therapist was singing in the background the march music.

Hands with mallets are working in the steady 4/4 beat, each hit 1/4

- one at the time,
- in own side,
- in the mirroring direction



Picture 39: Task 16

- Same exercise as previous, but the **hits doubled**. The tempo like in previous; every hit 1/4.

Notes:

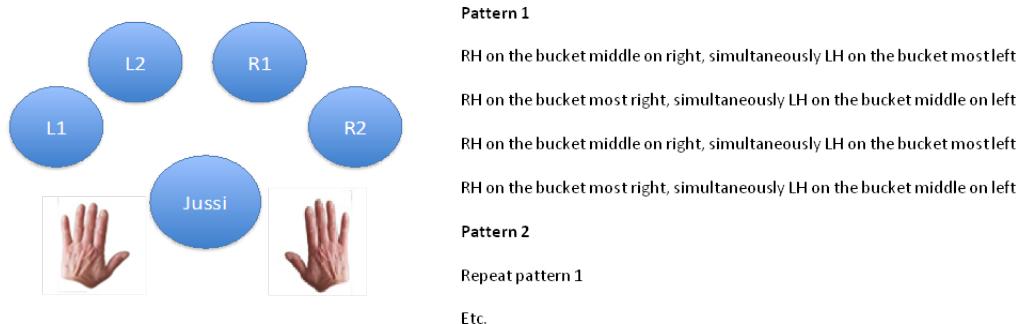
- The patient had a steady beat in his playing. He did not have any difficulties. It was easy to repeat the task with double hits.

Next the therapist wanted to try, if the patient could find the drums with his hands simultaneously.

### ***Task 16, variation 1***

Hands are working in steady 4/4 beat, each hit 1/4

- in the own side of the body
- simultaneously
- in the same direction, clockwise



Picture 40: Task 16, variation 1

### **Task 16, variation 2**

The variation 2 follows the variation 1. The only difference was the doubled taps each hit  $\frac{1}{4}$ . As in variation 1, hands are working in steady 4/4 beat.

- in the own side of the body
- simultaneously
- in the same direction, clockwise
- doubled taps

Notes:

- The tasks seemed to be easy for the patient. The rhythm, beat was steady.

Next was the task, where the patient should hold the steady beat in hitting four times with one hand and be aware of finding the right time to start with the other hand. The hands were moving like mirroring each other.

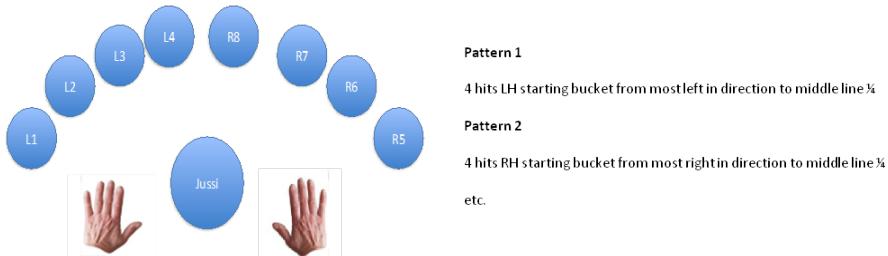
### **Task 17**

Hands are working in steady 4/4 beat, each hit  $\frac{1}{4}$

- one at the time,

- in own side,
- in the mirroring direction

8 buckets upside down on the table, in the form of slight arc, 4 buckets for the LH, 4 buckets for the RH.



Picture 41: Task 17

#### Notes:

- The patient did not have any difficulties with this task. The beat was steady.
- He was able to find the right hitting targets with LH and RH.

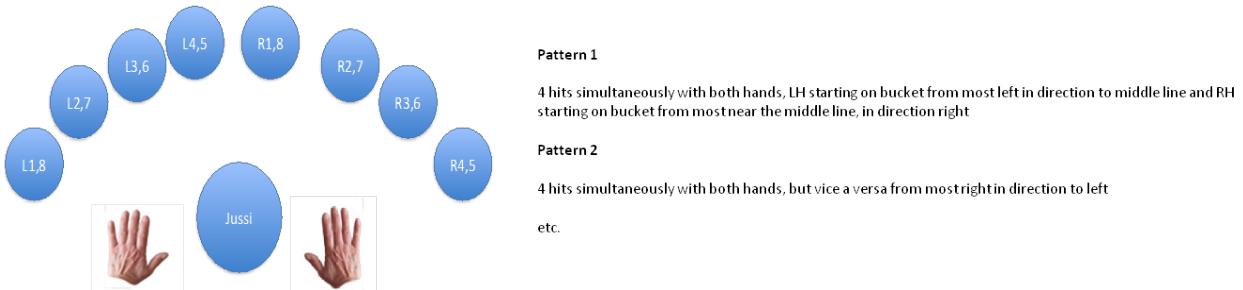
In the next task the therapist wanted to challenge the patient to work with both hands simultaneously. The hands should move in same direction, like mirroring each other.

#### **A variation 1 of the task 17:**

Hands are working steady 4/4 beat, each hit  $\frac{1}{4}$

- in the own side of the body
- simultaneously
- in the mirroring direction, 4x1/4 clockwise, 4x1/4 counter clockwise

8 buckets upside down on the table, in the form of slight arc. 4 buckets for the LH, 4 buckets for the RH.



Picture 42: Task 17, variation 1

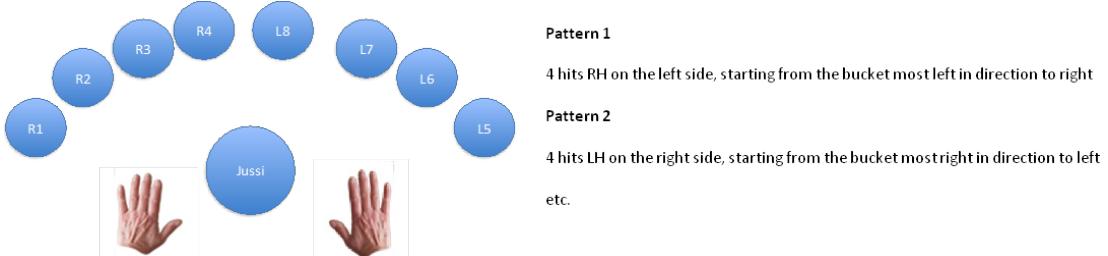
Notes:

- The patient seemed to enjoy the playing. He was concentrating well.

### Task 17 variation 2

Hands are working in steady 4/4 beat, each hit 1/4

- one at the time
- in the mirroring direction, 4x1/4 clockwise, 4x1/4 counter clockwise
- hands are working crossing the middle line



Picture 43: Task 17, variation 2

Notes:

- The patient was concentrating well. He found the working interesting and challenging.

### Task 2, Rhythm exercise

Walking 16 steps forwards, 16 steps backwards. The patient was asked to clap his hands together on the accent of the phrase (16. step) before changing the direction.

The therapist was singing “Kalle-Kustaan muori makaa hiljaan haudassaan”, giving the steady beat 4/4.

#### Notes:

The patient found the walking rhythm with the singing of the therapist, and also the clapping of hands.

This exercise was now easy to the patient. He enjoyed working.

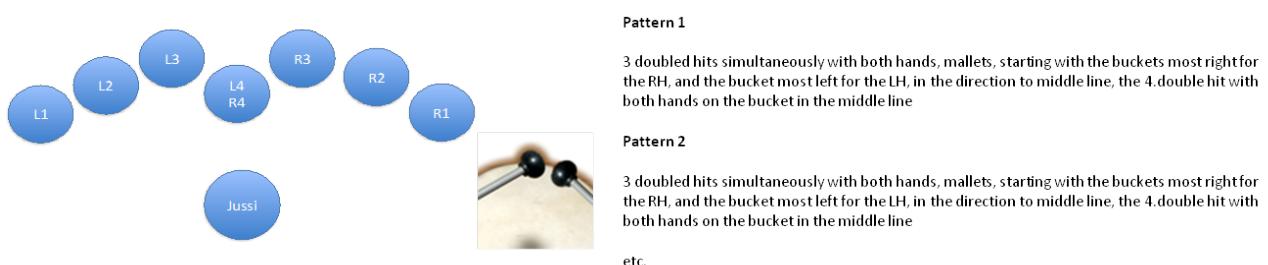
### Task 18

#### Videoclip 15. (00:00:36)

Hands are working with mallets, each hit doubled 1/4

- simultaneously
- in the mirroring direction
- in direction from side towards middle line

The patient was sitting on a stool, 7 buckets upside down affront of him on the table, in the form of slight arc. 3 buckets for the LH, 3 buckets for the RH and 1 common bucket in the middle for the both hands. The therapist was singing “Yksi pieni elefantti marssi näin” in the rhythm of marching.



Picture 44: Task 18

#### Notes:

- The range of movements of LH was smaller than of RH. RH was drumming a bit late and the hits with the mallet were a bit shaky.
- The patient did not hit every time in the middle of the bucket with his RH.

- 00:00:05      The patient did not catch the bucket with the right mallets first hit.
- 00:00:10      While the patient was looking his RH, the LH did not find the bucket with mallets first hit.
- 00:00:11      The patient did not find the bucket with the right mallets first hit, even he was looking at that direction.
- 00:00:13      The patient forgot to hit double in the bucket in the middle.
- 00:00:14      The patient did not find the bucket with mallets first hit with the LH.
- 00:00:18      The hit with the RH was shaky and the patient missed the double hit on the bucket in the middle.  
While concentrating, the patient was “working” also with his lips.  
The therapist stopped the singing and asked the patient to start again from the beginning.
- 00:00:19 - 00:00:36      The patient started from beginning without mistakes, but the hits with the RH were late and a bit shaky. He was following with his eyes the RH. He was very focused on working. The LH did not catch the middle part of the bucket most left.

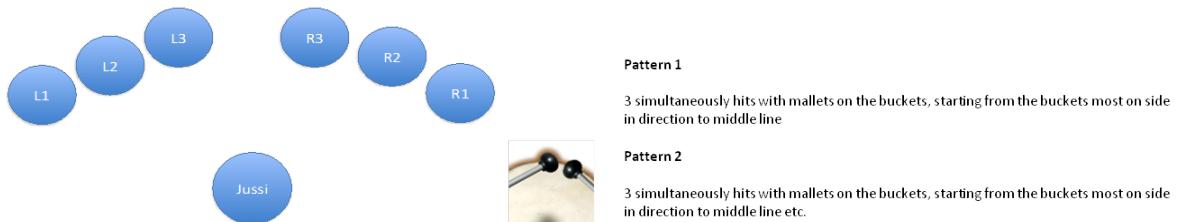
## **Task 19**

### **Video clip 16. (00:00:12)**

The hands are working with mallets in steady 3/4 beat

- simultaneously
- in the mirroring direction
- in direction from side towards middle line

The patient had 6 buckets standing upside down on the table, on the table in front of him in the form of slight arc. The therapist was singing a waltz “Oi muistattkos Emma”.



Picture 45: Task 19

#### Notes:

- The patient succeeded to drum in steady beat. He was very concentrated, not turning his head to any direction.
- He found well the hits in the middle of each bucket. The hits with the RH were shaky and not so exactly as the hits of LH.
- The therapist was singing quite slowly. The phrase (8x 3/4) was during 11 seconds.

#### **Task 19 variation1**

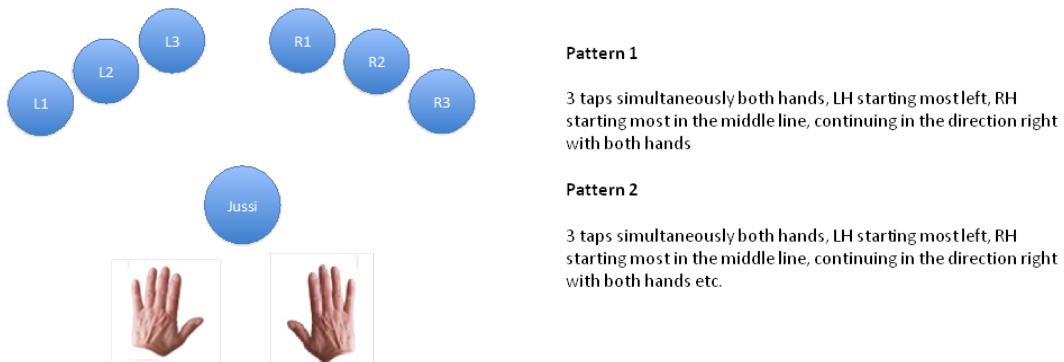
##### **Video clip 17. (00:00:50)**

The hands are working in steady 3/4 beat

- simultaneously
- in the same direction, clockwise

6 bucket were standing upside down on the table in front of the patient on the table, 3 on the right side and 3 on the left side in a figure of slight arc.

The therapist was singing a waltz “Oi muistatko Emma”.



Picture 46: Task 19, variation 1

- 00:00:00-00:00:10      The patient tried first to tap only the movements of the RH, and then separate movements of the LH.
- 00:00:11-00:00:15      The 3 first simultaneous taps with both hands went well, but then the patient did not find the exact movements of the RH. The timing of movements of the RH did not match with the LH. The patient forgot to tap the second bucket with the RH, or he tapped twice on the first bucket instead of tapping the second one. The LH found the buckets in the right order and the taps were hit nearly in middle of each bucket.
- 00:00:17      The patient tapped with his LH the bucket which was in area of the RH.
- 00:00:19      The patient tapped the middle bucket twice with his LH.  
The therapist asked the patient to put the hands in the right position and start again from the beginning.
- 00:00:23      The patient put his LH strongly on the bucket and slapped it and was smiling to the camera.
- 00:00:26      LH went correctly, but the RH did not find the third tap in the right timing.
- 00:00:29-00:00:30      This 3 taps (3/4) were well found.
- 00:00:31-00:00:33      The patient had difficulties to decide, where to put the RH
- 00:00:34-00:00:36      The next 3 taps (3/4) were found in right tempo.
- 00:00:37-00:00:40      The tapping was not founded. The therapist asked for a new start once again.
- 00:00:42-00:00:50      The patient tried to find the right movements on the right buckets, but he was missed.

#### Notes:

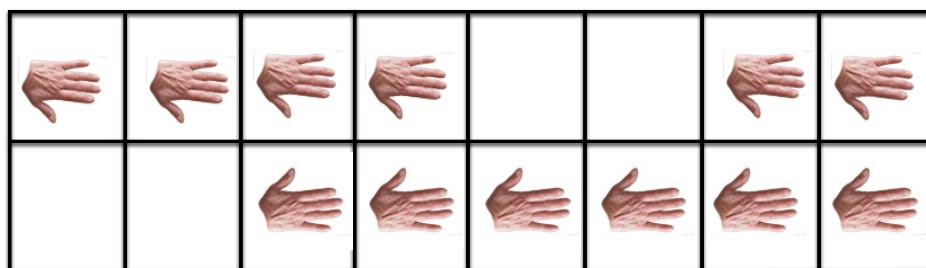
- The patient was concentrating very hard. The habitus of him seemed very tensed. The mouth, the lips were moving with the work. It turned out that the exercise was too difficult for the patient.  
The rhythm of waltz was difficult to find in movements.
- The therapist did not remember to encourage the patient in his work. The voice of the therapist was friendly; she was not blaming the patient for his mistakes.
- The patient had to concentrate to his RH very hard. He needed a lot of energy to decide, where to tap and when.

- The therapist slowed down the tempo of singing, when she noticed, that the patient could not follow.
- Surely the patient would have needed a break between these exercises.
- The patient did not lose his good mood in this work. He maintained the enthusiasm through the whole session.

## Structure of session 10 (8.3.2010)

### A Warm-up activity

The session started with warm-up activitys. The patient was tapping following the rudiments on the paper, known based on earlier sessions. The rudiment was drawn like **task 7var.1** where the LH tapped 2 times, simultaneously both hands 2 times, the RH 2 times, both hands 2 times etc.



Picture 47: A warm-up activity (Task 7, variation 1)

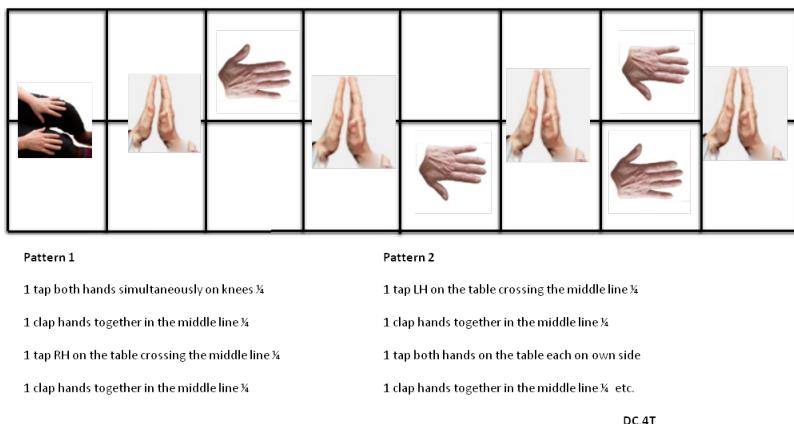
The patient was reading the orders, “map” fluently. Everything went well, until the therapist asked the patient to **work simultaneously with feet**.

He tried to stamp with his left leg simultaneously with the LH, and with his right leg simultaneously with his RH. This was too difficult for him. He tried couple times, without success.

### Task 20

The therapist was tapping with him and singing a melody with 4/4 beat

This was repeated couple times very well without mistakes.



Picture 48: Task 20

### Exercises in Playing Felt Drums

On the day of the session 10, the therapist should not cause noise in the working environment. Therefore she arranged instead of buckets as “drums” the felt drums.

Two 20x20 cm piece of red felt, two 15x15 cm piece green felt, two 12x12 cm piece of black fabric, and 10x10 cm piece of yellow felt.

The pieces of fabric, the “drums” were spread on the table in the figure of a circle, the left side identical with the right side.

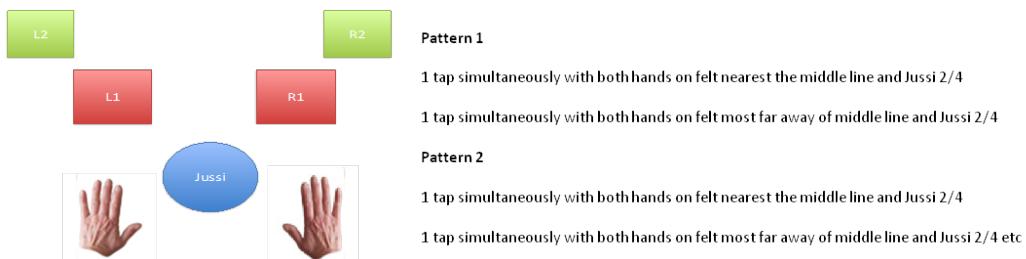
### Task 21

The hands are working with mallets in steady 4/4 beat

- in the own side of the body
- simultaneously
- in the mirroring direction
- direction forwards and sideways

The therapist was singing the song “Juokse sinä humma”, a melody with 4/4 beat

Each tap equalled 2/4



Picture 49: Task 21

#### Notes:

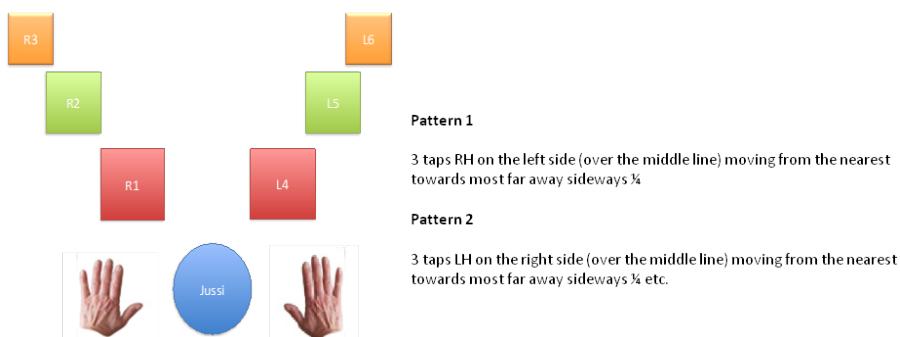
- Because the patient did not have any difficulties with this exercise, he was asked to do the same, but with **double tapping**,  $\frac{1}{4}$  on each tap. In addition, this seemed to be easy for him.

#### Task 22

Hands are working in steady 3/4 beat

- one at the time,
- crossing the middle line (in contralateral side)
- in the mirroring direction
- direction forwards and sideways

Exercise in the rhythm of waltz, 3/4 tempos, the therapist singing “Oi muistatko Emma”. The patient had in front of him 6 felt drums, symmetrical left and right side. The red drum was nearest him and the middle line, next the green drum further in front of him, and the most on the side and forward was the yellow one.



Picture 50: Task 22

Notes:

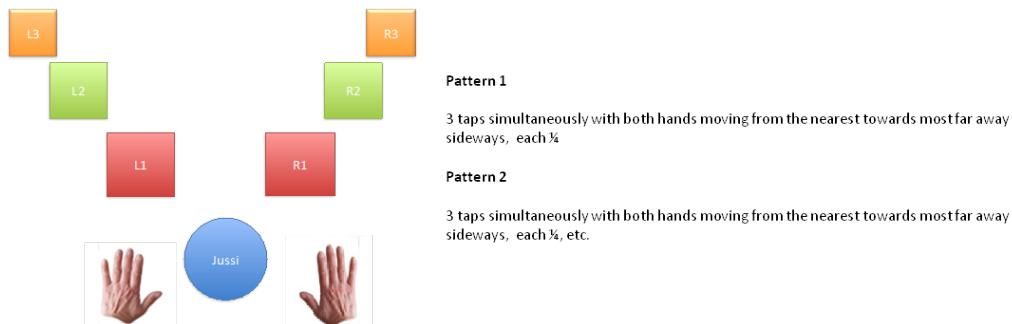
- The patient did not have any difficulties with this exercise.

### **Task 22 variation 1**

Hands are working in steady 3/4 beat

- in the own side of the body
- simultaneously
- in the mirroring direction
- direction forwards and sideways

Same position with the felt drums. The therapist was again singing the same waltz.



Picture 51: Task 22, variation 1

Notes:

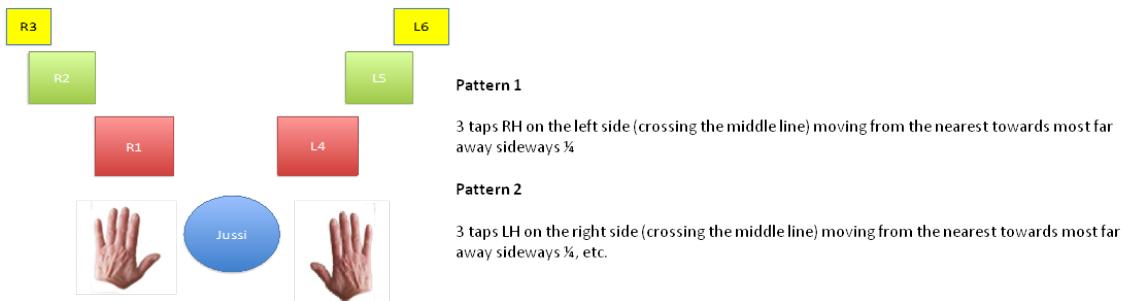
- The patient did not have any difficulties.
- The steady beat lasted.

### **Task 22 variation 2**

Hands are working in steady 3/4 beat

- one at the time
- crossing the middle line (in contralateral side)
- in the mirroring direction
- in the direction forwards and sideways

The therapist was again singing the same waltz.



Picture 52: Task 22, variation 2

Notes:

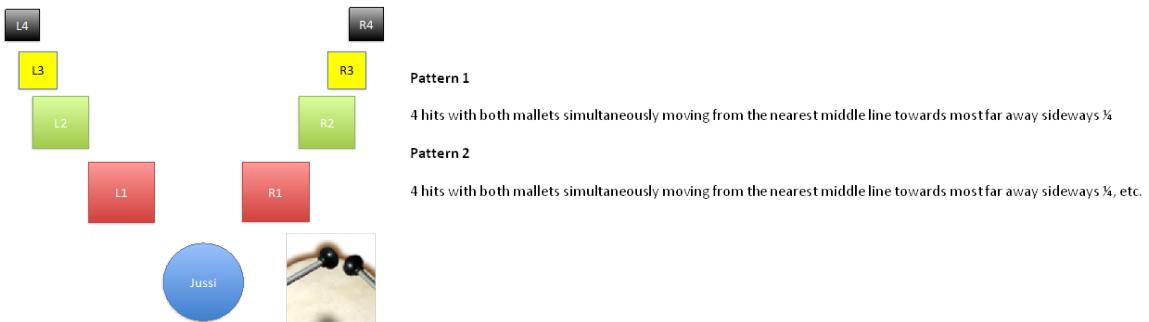
- In this exercise the most challenging point was the first tap with the LH on the red drum in the right side.
- The rhythm was late, while the LH searched the drum.

### Task 23

Hands are working with mallets in steady 4/4 beat

- in the own side of the body
- simultaneously
- in the mirroring direction
- direction forwards and sideways

The therapist was singing some melody in the 4/4 rhythms.



Picture 53: Task 23

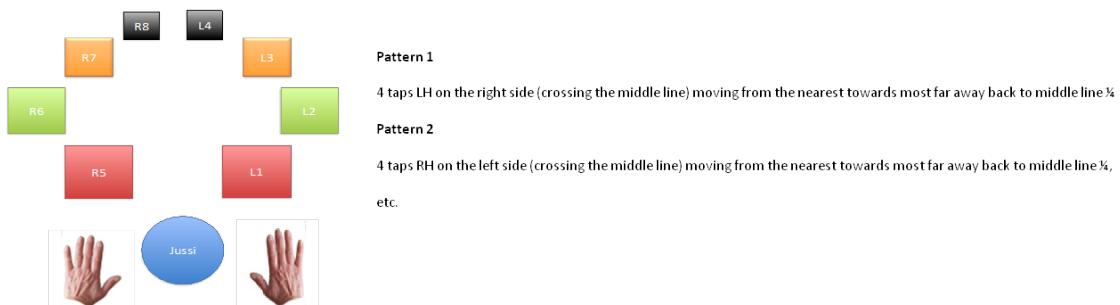
Notes:

This seemed to be easy for the patient. He played with steady beat.

## Task 24

### Video clip 18. (00:00:20)

- The hands are working in steady 4/4 beat
- one at the time,
- crossing the middle line (in contralateral side)
- from middle line sideways and forwards to middle line, mirroring
- The patient made 4 phrases (circles of 8x1/4 taps)



Picture 54: Task 24

#### Notes:

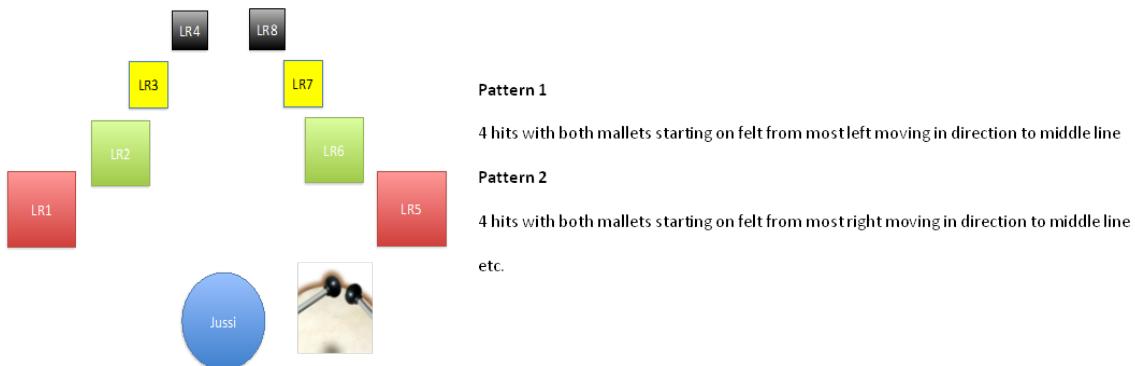
- The tapping was in so steady beat as the therapist was singing.
- The patient did not need to search the drums, **he knew, how to tap and where.**
- The patient had his hand in his lap while the other one was tapping. The timing was exact when he changed the working hand.
- The movements of the RH were not so exact as the ones of LH. The RH tapped the drum so that they moved a bit by every tapping.

## Task 24 variation 1

### Video clip 19. (00:00:29)

Hands are working with mallets in steady 4/4 beat

- simultaneously
- moving in same direction
- moving in direction from side to middle line
- The patient was drumming the 8 taps figure six times through.



Picture 55: Task 24, variation 1

Notes:

- The patient found the drums easy and in the rhythm of therapist's singing, which was not happening in steady beat.
- The drumming with the RH was a bit unstable. The patient wanted to hit only once with the right mallet, **but the right mallet touched every drum twice.**
- It seemed to be easy to use the RH as a pair with the LH.

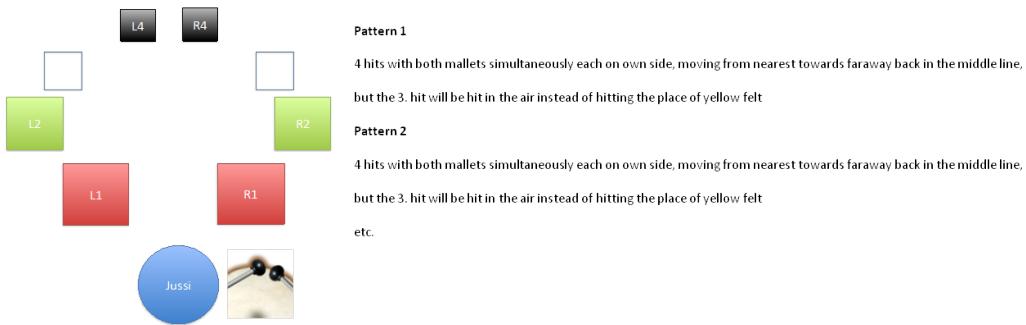
### **Task 24 variation 2**

#### **Video clip 20. (00:00:21)**

Hands are working in steady 4/4 beat, each hit 1/4

- simultaneously
- in the mirroring direction
- from middle line sideways and forwards to middle line

The therapist sang the same melody as in the previous session. The yellow felt drums were taken away and in their place there were empty areas.



Picture 56: Task 24, variation 2

#### Notes:

- The patient played 8 times this 4x1/4 tapping. Playing was fluent. The pauses were lasting exactly 1/4.
- The RH tapping on drums were like in the previous sessions, a bit unsure, doubled.
- The patient's grips on the mallets were similar in the both hands. The patient was well concentrated. He did not need to turn his head.
- The therapist and the patient were very delighted to notice, that this went so well.

### Exercises in playing xylophone

The therapist had planned to transfer the elements of all the previous sessions by asking the patient to play on the xylophone the song Hämä-, hämähäkki. The therapist had thought that the rhythmical elements were already familiar to the patient. Also the mallets were familiar to the patient. The patient had the song in front, left of him written in figure notes. The notes were scored on the xylophone with colours. The therapist gave the mallet in the patient's RH. The therapist accompanied the patient's playing by singing the song to a slow beat.

### Xylophone Exercise 1

#### Video clip 21. (00:00:09)

- 00:00:00 The patient started well, 3x1/4 notes in C, once 1/4 D, 2/4 E
- 00:00:05 Instead of 2/4 E, the patient played C
- 00:00:07 The patient could not decide, on which key he should put the next note. He tried to continue on a right key D and then the C. The

therapist intermitted the exercise and asked him to make a new start.

#### Notes:

- The patient was very determined, while he started to play. In this exercise the patient had to play one key to each syllable, which was twice so fast as in earlier exercises.
- The rhythm was clear and steady in the beginning.
- The patient was unsure of the following part and that made him to stop the playing.

The therapist noticed, that this switch from tapping rhythms to playing melodies was too radical. She put papers (in colours of figure notes) on the table side by side, like in xylophone. This “xylophone” was much bigger than a real one and the patient could play it by tapping the colours with his right hand.

He could read and play the notes. The therapist helped him by singing in the steady tempo.

The patient played:

“Hä-mä-, hä-mä( 4x1/4)  
-häk-ki(2x2/4),  
kii-pes lan-gal(4x1/4)-le(1x4/4)

in the right rhythm and he touched the right “keys” in the right order. When the patient played this exercise twice without mistakes, he returned back to xylophone playing.

#### ***Xylophone Excercise 2***

#### **Video clip 22. (00:00:26)**

The patient was playing again the same melody on the xylophone. He played it slowly and the therapist was accompanying him by singing. The therapist adapted her tempo in the patient’s ability to find the right keys.

- 00:00:00-00:00:09      The patient played the right keys, except the last one. Instead of C, he played D. The therapist asked him to take a new start.
- 00:00:13                  The patient started to play again.

He needed time to make decisions, which keys to play. He played very slowly right keys on hä-mä,hä-mä-häk-ki, kii-pes lang- (Instead of 4 first 1/4 notes The patient played 5 hits).

He did not know, how to continue. He played C instead of E and C. Frustrated of mistakes, the patient started to play all keys upwards and downwards on xylophone. In the end of the phrase he changed the stick in the left hand.

Notes:

- The patient had difficulties to touch the right keys with the drumstick in his RH.
- The small sideways movements of the RH were demanding.
- All hits were unsure and often he had to look for the right point to hit.

### **Xylophone Excercise 3**

#### **Video clip 23. (00:00:24)**

The therapist was singing the same song adapting to the patient's tempo in finding keys.

- 00:00:00-00:00:06      The same exercise again, the drumstick still in the RH. The patient played the phrase nicely, slowly. But again, in the same place, lang-, gal-, he had difficulties to find the keys. After gal- he let the stick run on many keys. The therapist helped him by telling that he should play the red key on syllable “-le”.
- 00:00:12                  C, the red one was found. He said, that from here on I do not know.

00:00:15-00:00:24      The patient started again, slowly. He did not hit the target in every case, but he continued although. Everything went fine, but the last key was again lost. The song ended in D instead of C.  
The patient was smiling!

## APPENDIX 2

## Categorizing the material

TASKS	CONTINUITY				DISCONTINUITY			
	1 TARGET	2 TARGETS	3 TARGETS	4 TARGETS	1 TARGET	2 TARGETS	3 TARGETS	4 TARGETS
1					▲	●	■	
2 marching tasks								
3 tapping with legs								
4					▲	■		
5	▲							
6		■	■					
7	■					task 7 var.1	■	
8 var.2	●	■				tasks 8, 8var.1	●	■
9		■	■					
9 var1		▲	■					
10			▲	■				
10 var.1			●	■				
11,11 var.1			■					
11var.2			▲	■				
12, var.Jussi			▲	■				
13	■	●				■	■	
13 var.Jussi								
14			■					■
15			■					
rudiment 5	▲	■						
rudiment6	▲	■						
rud. 7+9					▲	■		
rud. 8+10					▲	■		
20							■	■

Symbols	Explanation
■	Crossing middle line
■	Challenging choreography of hand movements
●	Different timing of hits
▲	Amount of hits

### **APPENDIX 3 Comparing the categorized factors and the problems in playing**

The tasks painted in green were the video recorded ones.

## Session 1

Task	Regularity of tapping	Correct amount of taps	Using of own speech	Clearness of the voice	Therapist Singing,Reciting, Background Music	Mood	Repeating >successed performing	Remarks	Coordination Power etc.
1	ok	ok	ok	ok	R	ok	many	difficulties	Problems

## Session 2

Task	Regularity of tapping	Correct amount of taps	Using of own speech	Clearness of the voice	Therapist Singing,Reciting, Background Music	Mood	Repeating >successed performing	Remarks	Coordination Power etc.
1	ok	ok	ok	ok	R	ok	2	Succeed without therapist reciting	Too much power
3	ok	ok			R	ok	2	Better without reciting	Ok
4	Probl.	Probl.	ok	ok	R	ok	3	The patient used numbers	Ok-
5	Probl.	Probl.	ok	ok	(R,numbers)	ok	2		Prob.
Brain reboot	Trampoline								
5	50% ok Probl.	50% ok Probl.	ok-	ok-	R	ok	2	Brain rebooting helped	ok
6	ok	ok			M	ok		Easy	ok

## Session 3

<b>re-boot</b>									
<b>5</b>	ok	ok	ok	ok	R	o k		Easy	ok

## Session 4

Task	Regularity of tapping	Correct amount of taps	Using of own speech	Clearness of the voice	Therapist Singing,Reciting, Background Music	Mood	Repeating >successed performing	Remarks	Coordination Power etc.
2					March music	ok		marching	ok
1	ok	ok			S	ok		easy	ok
5	ok	ok			S	ok	Double taps	easy	ok
7	ok	ok			S	ok		easy	ok
7 var1	ok	ok			S	ok		easy	ok
8	ok	ok			S	ok		easy	ok
8 var1	ok	ok			S	ok		easy	ok
9	ok	ok			S	ok		easy	ok
9 var1	ok	ok			S	ok		easy	ok
10	ok	ok			S	ok		easy	ok
10 v.1	ok	ok			S	ok		easy	ok
11	ok	ok			S	ok		easy	ok
11 v.1	ok	ok			S	ok		easy	ok
11 v.2	ok	ok			S	ok	Demanding!!	easy	ok

## Session 5

## Session 6

Task	Regularity of tapping	Correct amount of taps	Using of own speech	Clearness of the voice	Therapist Singing, Reciting, Background Music	M o o d	Repeating >successed performing	Remarks	Coordination Power etc.
2					March music	o k	marching		ok
8 var2	ok -	ok -	ok -	ok -	R	o k		<b>Not easy</b>	ok -
13	ok -	probl.	ok -	ok -	R	o k	2	difficulties	probl.
13	probl.	probl.	ok	ok	R	o k		difficulties	probl.
13	ok -	ok -	ok	ok	R+ therapist tapping	o k		Easy!!	ok
11	ok	ok			M	o k		easy	ok
14	ok	ok			M	o k		easy	ok
1-12	Imitating each other				M			Easy!!	ok
13var The patient	ok	ok			M	o k		easy	ok
8+3	ok	ok			M	o k		easy	ok
2	marching on the step boards							<b>Not easy</b>	ok -

## Session 7

Task	Regularity of tapping	Correct amount of taps	Using of own speech	Clearness of the voice	Therapist Singing, Reciting, Background Music	M o o d	Repeating >successed performing	Remarks	Coordination Power etc.
2					Music (I.Goodman)	o k		marching	ok
9+var	ok	ok	ok	ok	R	o k		easy	ok
10+var	ok	ok	ok	ok	R	o k		easy	ok
15	ok -	ok -	ok -	ok -	R	o k	3-4	<b>Not easy</b>	ok -
12	ok	ok				o k	2	standing	ok
12var1	ok	ok			M	o k		Sitting, easy	ok
12var2	ok	ok			M	o k		Marching, easy	ok
1-10rud	ok	ok	ok	ok	R	o k		easy	ok
6+8 rud	ok	ok	ok	ok	R	o k		easy	ok
5+7 rud	ok	ok	ok	ok	R	o k		easy	ok
8+10 rud	Probl.	Probl.	ok -	ok -	R	o k	2-4	Probl.	ok -
7+9 rud	Probl.	Probl.	ok -	ok -	R	o k	2-4	Probl.	ok -
Brain reboot.	Circle drawing								
7+9 rud	ok	ok	ok	ok	R	o k		easy	ok
8+10 rud	ok	ok	ok	ok	R	o k		easy	ok
3+legs	ok	ok	ok	ok	R	o k		easy	ok

## Session 8

Task	Regularity of tapping	Correct amount of taps	Using of own speech	Clearness of the voice	Therapist Singing, Reciting, Background Music	M o o d	Repeating >successed performing	Remarks	Coordination Power etc.
2					March music	o k		marching	ok
9	ok	ok	ok	ok	R	o k		easy	ok
10	ok	ok	ok	ok	R	o k		easy	ok
15	Probl.	ok	ok	ok	R	o k	2-4	probl.	No concentration
Brain reboot.	Circle drawing								
15	ok	ok	ok	ok	R	o k		easy	Ok!!
2	Marching on the stepboards				S	o k	Many times	Probl. with directions	enjoyable
1-3rud	ok	ok				o k		easy	ok
6rud	probl	probl.	counting		S	o k		Probl.	Probl.
5rud	ok	probl.	counting	ok	S	o k		Probl.	Probl.
7+9rud	probl	probl.	counting	probl.	R counting	o k	2-3	Probl.	Changing hands
8+10 rud	ok	ok	counting	ok -	R counting	o k	2-3	Probl.	Changing hands
8+10 rud	ok	ok	singing	ok	S + showing with pencil	o k		easy	The patient sang!

## Session 9

## - Drumming

Task	Regularity of Drumming, Amount of drums	Correct amount of hits	Using hands= H Mallets= M	Direction	Therapist Singing, Reciting Background Music	M o o d	Repeating >successed performing	Remarks	Coordination Power Etc.
2					March music	o k		marching	ok
16	Ok, 4	ok	M	Mirroring	S	o k		easy	ok
16 double d	Ok, 4	ok	M	Mirroring	S	o k		easy	ok
16 var1	Ok, 4	ok	H	Clockwise, Simult.	S	o k		easy	ok
16 var2	Ok, 4	ok	H	Clockwise, Simult.	S	o k		easy	ok
17	Ok, 8	ok	H	Mirroring, One at the time	S	o k		easy	ok
17 var 1	Ok, 8	ok	H	Simult. Mirroring, Clock+anti Clockwise	S	o k		easy	ok
17 var2	Ok, 8	ok	H	One at the time, Mirroring, Glock+anti Clockwise	S	o k		easy	ok
2	marching on the stepboards				S	o	Many	easy	enjoyable

						k	times		
18	Probl., 7	probl.	M	Simult. Mirroring	S	o k		Mouth working	Probl.
19	Ok -, 6	ok	M	Simult. Mirroring	S	o k		easy	3/4
19 var1	Probl., 6	probl.	H	Simult. Clockwise	S	o k		Probl. Right hand	3/4 Probl.

**Session 10**

- Tapping (tasks 2 – 7 var1+legs)
- Drumming (Tasks 20 – 24)
- Playing instruments (Xylophone 1-3)

Task	Regularity of tapping	Correct amount of taps	Using of own speech	Clearness of the voice	Therapist Singing, Reciting, Background Music	M o o d	Repeating >successed performing	Remarks	Coordination Power etc.
2					March music	o k	marching		ok
1-10 rud	ok	ok	ok	Ok	R	o k		easy	ok
7var1	ok	ok	ok	Ok	S	o k		easy	ok
7var1 +legs	probl.	probl.			S	o k	2	Legs with	probl.

Task	Regularity of Drumming	Amount of drums	Correct amount of hits	Using hands=H Mallets=M	Direction	Therapist Singing, Reciting, Background Music	M o o d	Repeating >successed performing	Remarks	Coordination Power etc.
20	ok	ok				S	o k		easy	Enjoyable, many repeatings
21	Ok, 4	ok	H	Simult. Mirroring	S	o k		easy	Ok 4/4	
21 doub.	Ok, 4	ok	H	Simult. Mirroring	S	o k		easy	Ok 4/4	
22	Ok, 6	ok	H	One at the time, Mirroring, <b>Crossing</b>	S	o k		easy	Ok 3/4	
22 var1	Ok, 6	ok	H	Simult. Mirroring	S	o k		easy	Ok 3/4	
22 var2	Ok -, 6	ok	H	One at the time, Mirroring, <b>Crossing</b>	S	o k			Left hand probl. With rhythm and position 3/4	
23	Ok, 8	ok	M	Simult. Mirroring	S	o k		easy	Ok 4/4	
24	Ok, 8	ok	H	One at the time, Mirroring, <b>Crossing</b>	S	o k		easy	4/4	
24 var1	Ok, 8	ok	M	Simult. Clock+anti clockwise	S	o k		easy	4/4, right hand probl.	
24 var 2	Ok, 8	ok	M	Simult. Mirroring	S	o		easy	4/4	

						k			
Xylophon 1	probl.	probl.	M		S	o k		probl.	probl.
Xylophon 2	probl.	probl.	M		S	o k		probl.	probl.
Xylophon 3	probl.	probl.	M		S	o k		easy	ok -