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Executive Summary

We collected a set of exercises for different stages of stroke recovery. We combined the results of the literature analysis with our practical clinical knowledge. In addition, we tested clinical relevant exercises in a telerehabilitation setting via video conference. Based on the results of these efforts we define basic principles for treatment of the upper limb using preferred distal movements and evidence-based therapeutic methods of treatment. Therefore we developed a set of concrete rehabilitation exercises and presented them to the consortium. We will focus on motor function training including bimanual activities, coordination, reach, grasp, and dexterity tasks. According to the results of discussing selected exercises and technical capabilities, we modified the rehabilitation exercises and present the final selection in this manuscript.





List of abbreviations

Abbreviation	Explanation
ID	Identifier
SRM	Selective Repetitive Movements
AAT	Arm Ability Training
MST	Music Supported Therapy
ADL	Activities of Daily Living
abd.	abduction
flex.	flexion
Т.	thumb
Р.	palmar





1 Selection and rehabilitation training

1.1 Analysis of literature

The S2e guideline of the German neurologic rehabilitation society "Motoric rehabilitation of the upper extremity in stroke patients" was our most important database [1]. Furthermore, we considered relevant review articles [e.g. 2]. On the one hand we extracted principles of motor learning and on the other hand concrete therapeutic interventions. We will pursue three types of training, "Selective Repetitive Movements" of the upper limb, "Arm Ability Training", and "Music Supported Therapy" as possible interventions. "Selective Repetitive Movements (SRM)" of the upper limb is a therapeutic approach for patients even with massive impairment; it employs no complex movements, a high repetition rate, and can easily be shaped to the rising performance of the patients [3]. "Arm Ability Training" (AAT) is used to increase grip, steadiness, coordination, dexterity, aiming, strength endurance and speed of hand and finger movements. It includes eight different items and is favourably used in less to moderate handicapped stroke patients [4]."Music Supported Therapy" (MST) was recently developed and evaluated. It includes repetitive and shaping elements and employs direct auditory feedback, too. It uses instruments in a step by step learning practice for patients with less or moderate impairments [5]. Details about all types of training will be given in section 1.5.

1.2 Integration of clinical knowledge and first telerehabilitation experiences

We builded up a video conference system to investigated telemedical therapeutic interventions in this setting. In general younger aged patients performed better, communication with aphasic patients was complicated (in some cases even impossible), neuropsychological deficits were often a barrier. In particular, complex verbal instructions were often not understood by the patients. "Selective Repetitive Movements" and "Arm Ability Training" were the best feasible therapeutic exercises in this context. In our opinion this is explained by the good visual demonstrability of these exercises.

1.3 Consensus on basic principles

We presented the upper mentioned proposals during the kick-off meeting in Frankfurt / Oder. The representatives of the consortium partners decided the following basic principles for the project:

- 1. We will restrict the training to the upper limb
- 2. Therapy should employ evidence based training interventions
- 3. Focus on motor performance but take sensitivity and cognitive capability into account.

1.4 Subsets of training interventions

Basing on these specifications we developed three subsets of training interventions. The "Selective Repetitive Movements" subset includes the joints and the movements. Because distal movements are able to proximalize, we focussed on distal movements. The specific movements are described in detail in





Chapter 1.5. In our opinion, these trainings could be perfectly combined with serious games. High repetition frequencies are monotonous in general. That could be avoided by a serious gaming structure. Motivation, compliance and attention could be forced, too.

The "Arm Ability Training" subset uses objects of daily living. For this reason we see a huge potential for motivating patients. In particular, patients with deficits in the activities of their daily living will be addressed. Not only motor performance but also sensitivity and cognitive capability are necessary to execute the interventions and will be trained in this subset in a focussed way. The "Music Supported Training" subset requires no specific musical education. It employs music as a motivation instrument. Different musical instruments can be used and we decided to use a midi-keyboard. The "musical supported training" is strictly structured. A comprehensive training guideline ensures a reliable and standardized instruction of the patients. On the one hand, the three training intervention subsets make it possible to enclose patients with different impairments in the telerehabilitation setting. On the other hand there is enough variability for a certain patient to choose different training interventions and to preserve his motivation and compliance. We presented and discussed the upper mentioned subsets of interventions with all consortium partners. The three proposed subsets were accepted and will be presented in detail in the next chapter.

1.5 Rehabilitation training

This section introduces all developed subsets of training intervention in detail below.

1.5.1 "Selective Repetitive Movements"with serious gaming

This kind of training is suitable for patients with massive impairments. Movements should be done active by one joint or as less complex as possible. Favourite movements are the distal movements: pronation, supination, dorsiflexion, palmar flexion, ulnar abduction, radial abduction, finger flexion, finger extension, finger spread, thumb abduction and pinch grip. One task should not be done less than 5 minutes, at most 15 minutes. One task means, e.g. executing dorsiflexion as often as possible, at largest range of motion, as fast as possible in the given time. Goal of each task should be to get a larger range of motion, more strength and better endurance to achieve basic hand functions. Basic hand functions are important for involving the paretic upper limb in the activities of daily living. To ensure success, each exercise needs to be adapted to the rising performance limit. This procedure is called shaping. Shaping modalities are for instance:

- With or without gravity
- Movement speed
- Training duration (per exercise)
- Use of weights
- Use of limits or checkmarks.





1.5.1.1 Pronation/Supination

Pronation (fig. 1) and supination (fig.2) are turning motor activities of the forearm. Turning point is the elbow. Pronation shows dorsal side of the hand at the top. Supination shows palmar side of the hand on the top. Dorsal is the back of the hand. Palmar is the flat of the hand.

While exercise pronation or / and supination the forearms lays on a table.





Figure 2 Supination

Figure 1 Pronation

1.5.1.2 Dorsi flexion/Palmar flexion

Dorsi flexion and palmar flexion are one joint motor activities of the hand. The wrist is the used joint. While exercising dorsi flexion or / and palmar flexion the forearm lays on a table. In basic position one, the forearm in position 0° without gravity (fig. 3). Dorsi flexion (fig.4) is the activity in the back of the hand direction. Palmar flexion (fig. 5) is the activity in the palm of the hand direction.



Figure 3 Position 0°

Basic position two, forearm on a pack (fig. 4; 5). This allows to execute the movement over a wider range of motion.



Figure 4 Dorsi flexion



Figure 5 Palmar flexion





1.6.1.3 Radial abduction/ Ulnar abduction

Radial abduction (fig. 6) and ulnar abduction (fig.7) are one joint motor activities of the hand. The wrist is the used joint. Radial abduction goes in thumb direction. Ulnar abduction goes in cubital direction. While exercising radial abduction or / and ulnar abduction the forearms mostly lays with the palm on the table (basic position one fig. 6 and fig.7, without gravity). Basic position two: forearm on a pack, position of the wrist in pronation / supination direction 0° and in dorsiflexion / palmarflexion 0° (see fig. 8 and fig.9, with gravity).





Figure 6 Radial abduction

Figure 7 Ulnar abduction



Figure 8 Radial abduction against gravity



Figure 9 Ulnar abduction with gravity

1.6.1.4 Finger flexion/ Finger extension

Finger flexion (fig. 10) and finger extension (fig.11) are simple motor activities of the hand using multiple joints. All small finger joints are the used joints. Needed joints are metacarpophalangeal joints (knuckle joints), proximal interphalangeal joints and distal interphalangeal joints. Finger flexion is making a fist. Finger extension is to open the fist. While exercising finger flexion or / and finger extension the forearm lays on a table (Basic position one supination / pronation 0°, dorsiflexion / palmarflexion of the wrist 0°, without gravity). Basic position two: palm of the hand on a pack (fig. 12, finger extension with gravity).



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Figure 10 Finger flexion

Figure 11 Finger extension



Figure 12 Finger extension against gravity

1.6.1.5 Thumb abduction/ Thumb adduction

Thumb abduction (fig. 13) and thumb adduction (fig.14) are one joint motor activities of the thumb. The metacarpophalangeal joint of the thumb is the used joint. Thumb abduction direction goes away from hand. Finger adduction direction goes close to hand. While exercise thumb abduction or / and thumb adduction the forearms and the palm of the hand lay flat on a table (Basic position one, without gravity). Basic position two: forearm and ulnar side of the hand lay on the table (fig. 15 and fig. 16, with gravity).



Figure 13 Thumb abduction



Figure 14 Thumb adduction



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Figure 15 Starting position



Figure 16 Thumb abduction against gravity

1.6.1.6 Finger spread (finger abduction/ finger adduction)

Finger abduction (fig.17) and finger adduction (fig. 18), also called finger spread are motor activities of the metacarpophalangeal joints of all five fingers.

Basic position one forearm and palm of the hand lay flat on a table (without gravity).



Figure 17 Finger abduction



Figure 18 Finger adduction

1.6.1.7 Pinch grip

Pinch grip (fig. 19-22) is a motor activity of the hand using different fingers selectively. Two fingers are used. The thumb is in opposition to one of the other fingers (digit II to digit V). The finger pulps need to contact. Used joints are all small finger joints (metacarpophalangeal joints, proximal interphalangeal joints and distal interphalangeal joints). While exercise pinch grip the forearm and the ulnar side of the hand lay on a table (Basic position one).



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Figure 19 Thumb to index finger



Figure 20 Thumb to middle finger



Figure 21 Thumb to ring finger



Figure 22 Thumb to small finger

1.6.1.8 Shaping possibilities for SRM

Repetitive training of simple movements is monotonous. Even increasing success will not keep the motivation of the patient on a high level. Serious gaming may increase the attention and motivation of the patient. Each "level" of a game is reached, when specific tasks are fulfilled. In our context fulfilling of tasks is defined by moving in a certain direction, with a minimal movement speed, with a specific number of repetitions and so on. In other words we can define the sequence of tasks by modifying the shaping variables of the trained movements. For each movement a sequence of shaping variables needs to be developed. In the following sections we describe the principle shaping possibilities for each movement.

1.6.1.8.1 Shaping pronation / supination

Shaping possibilities:

- Movement speed,
- Training duration (per exercise)
- Use of weights
- Use limits or checkmarks.

See fig. 23 to fig. 25 shaping example for use of weights, a training possibility with a dumbbell



Figure 23 Pronation



Figure 24 Position 0°



Figure 25 Supination





See fig. 26 to fig. 27 shaping example for use of checkmark. The patient is advised to reach a checkmark. After enlarging the range of motion to the first checkmark, the next checkmark is the next target.



Figure 26 Position 0°

Figure 27 Supination to a given checkmark

1.6.1.8.2 Shaping dorsi flexion

Shaping possibilities:

- Gravity
- Movement speed
- Training duration (per exercise)
- Use of weight
- Use of limit or checkmark.

See fig. 28 and fig. 29 shaping example for working against gravity.



Figure 28 Starting position



Figure 29 Dorsi flexion against gravity





See fig.30 – 32 shaping example for using weights, training with a dumbbell.



Figure 30 Starting position



Figure 31 Position 0°



Figure 32 Dorsi flexion with dumbbell

See fig. 33 and fig. 34 shaping example for use of checkmark.



Figure 33 Starting position



Figure 34 Dorsi flexion with given checkmark

1.6.1.8.3 Shaping palmar flexion

Shaping possibilities:

- Gravity
- Movement speed
- Training duration (per exercise)
- Use of weight
- Use of limit or checkmark

See fig. 35 to fig. 37 shaping example for use of weight, training with a dumbbell.



Figure 35 Starting position

Figure 36 Position 0°

Figure 37 P. flex. against resistance

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See fig. 38 and fig. 39 another basic position and shaping example to train against a resistance. For example a flexible ball has to be squeezed.



Figure 38 Starting position



Figure 39 End position

1.6.1.8.4 Shaping ulnar abduction

Shaping possibilities:

- Movement speed
- Training duration (per exercise)
- Use of weight
- Use of limit or checkmark

See fig. 40 and fig. 41 shaping example for use of weight, training against resistance (in this example anti-slip foil increases the resistance).



Figure 40 Starting position



Figure 41 Ulnar abduction against resistance





See fig. 42 and fig. 43 shaping example for use of checkmark.



Figure 42 Starting position



Figure 43 Ulnar abduction with given checkmark

1.6.1.8.5 Shaping radial abduction

Shaping possibilities:

- Gravity
- Movement speed
- Training duration (per exercise)
- Use of weights
- Use of limit or checkmark

See fig. 44 to fig. 46 shaping example for working against gravity.



Figure 44 Starting position



Figure 45 Position 0°



Figure 46 Radial abd. against gravity

See fig. 47 and fig. 48 shaping example for use of weights, training with a dumbbell.



Figure 47 Starting position





Figure 48 Radial abduction with a dumbbell





1.6.1.8.6 Shaping finger extension

Shaping possibilities:

- Gravity
- Movement speed
- Training duration (per exercise)
- Use of weight / resistance
- Use of limit or checkmark.

See fig. 49 and fig. 50 shaping example by working against gravity.



Figure 49 Starting position



Figure 50 Finger extension against gravity

See fig. 51 and fig. 52 shaping example for use of checkmark.



Figure 51 Starting position



Figure 52 Finger extension by given checkmark

See fig. 53 and fig. 54 shaping example for working against gravity by using single / selective fingers.



Figure 53 Finger extension index finger



Figure 54 Finger extension middle finger





1.6.1.8.7 Shaping finger flexion

Shaping possibilities:

- Movement speed
- Training duration (per exercise) •
- Use of weight / resistance •

See fig. 55 shaping example for use of resistance/work against resistance by the fist/all fingers, in fig. 56 selective fingers.





Figure 55 Finger flexion against resistance Figure 56 Finger flex. index finger against resistance

1.6.1.8.8 Shaping fingerabduction/adduction

Shaping possibilities:

- Movement speed •
- Training duration (per exercise)
- Use of weight / resistance •

See fig. 57 and fig. 58 shaping example for use of resistance.



Figure 57 Starting position



Figure 58 Finger adduction against resistance





1.6.1.8.9 Shaping thumb abduction / adduction

Shaping possibilities:

- Gravity
- Movement speed
- Training duration (per exercise)
- Use of limit or checkmark

See fig. 59 and fig. 60 shaping example for working against gravity.







Figure 60 Thumb abduction against gravity

See fig. 61 – 63 shaping example for use of checkmarks.



Figure 61 Starting position



Figure 62 Thumb abduction



Figure 63 T. abd. by given checkmark

1.6.1.8.10 Shaping pinch grip

Shaping possibilities:

- Movement speed
- Training duration (per exercise)
- Use of weight / resistance





See fig. 64 and fig. 65 shaping example for use of resistance.







Figure 65 Pinch grip against resistance

1.5.2 "Using Objects" according to Arm Ability Training

This subset of training intervention is employable for patients with mild to moderate impairments. It is advisable to exercise highly repetitive (many repetitions during a training session) and often (many training sessions during a week). We propose seven objects and their correlating tasks.

The goal of each task is to get better grip force, steadiness, coordination, dexterity, aiming, strength endurance and speed of hand and finger movements. Training should stimulate the patient to involve the paretic upper limb more extensively in the activities of daily living. See the described distal movements below for further details. Each exercise needs to be adapted to the rising performance limit as well. Shaping possibilities will be described for each object in detail.

General possibilities of shaping

- speed
- weight
- level of difficulty

1.6.2.1 Coins

Goal:

• Better outcome of grasp, dexterity, coordination, speed, aiming

Structure:

- Used material: marked base and the objects to turn (coins, glass nuggets, buttons, flat washer)
- Sizes, numbers and kinds of objects like coins to turn are given
- Objects are located in a row of ten
- There are four of these rows one below the other
- The beginning of the exercise is in the first row on top
- The very first object is located opposite to the affected arm
- An exercise takes one minute, turned objects are counted
- Repeat each "one minute exercise" for four times







Figure 66 Example of "Coins"

Shaping:

- Use small objects (small coins, flat washers, ...)
- Use bigger objects (buttons, big coins, glass nuggets, ...)
- Use many different sizes or few different sizes

Shaping example by using small and smaller objects (fig. 67-69):



Figure 67 Buttons

Figure 68 Glass nuggets

Figure 69 Coins

1.5.2.2 Bolts & Nuts

Goal:

• Better outcome of grasp, dexterity, coordination, speed, aiming, bimanual activities

Structure:

- Used material: bolts and nuts in different sizes
- Sizes and numbers of bolts and nuts to screw are given
- Objects are located in a vertical row
- The objects are arranged in a periodic structure of size (big -medium-small, ...)
- The nuts to screw are on the affected side
- The unaffected hand holds the bolt
- Screw and bolt needs to be flushed with
- The beginning of the exercise is on top





- An exercise takes one minute
- Repeat each "one minute exercise" for 4 times



Figure 70 Example of "Bolts & Nuts"

Shaping:

- Low level of difficulty:
 - Use of medium and big bolts and nuts (2-3 different sizes)
 - Use of few bots and nuts (8-12 kinds/pieces)
 - The non-paretic hand may help



Figure 71 Example low level





- High level of difficulty:
 - Use of medium and small bolts and nuts (3-5 different sizes)
 - Many bolts and nuts (12-18 kinds)
 - Only screw with paretic hand (use healthy hand just to fix the bolt)



Figure 72 Example high level

1.6.2.3 Construction blocks

Goal:

• Better outcome of grasp, dexterity, arm moves, bimanual activities, coordination, strength endurance

Structure:

- Used material: construction blocks in 3 different sizes (e.g. mega blocks[™], duplo[™], lego[™]) and different colors, profile
- Time is measured and given as a feedback
- The task is to build up a given construction out of single pieces / blocks
- Different settings of tasks/levels of a construction design will be given

Shaping:

- Different number of blocks (less/10 to many/75)
- Lower level, e.g. "build a tower"/ build a small tower of ten pieces
- Higher level, e.g. "build a high tower" of 50 pieces or build a tower, house or car by instruction
- Construction design via screen





1.6.2.4 "Knulli"

Goal:

• Better outcome of grasp, dexterity, bimanual activities, coordination, strength endurance

Structure:

- Used material: "Knulli" and small objects (coins, paper-clips, nuts, buttons, glass nuggets, dry beans, pebbles)
- "Knulli" is a tennis ball with a sliced mouth (fig.73)



Figure 73 "Knulli"

- The task is to feed "Knulli" with the picked up objects (paretic hand can be used as holding or picking up hand)
- "Knulli" opens the "mouth" when squeezed
- Time is measured and given as a feedback
- Different settings of tasks/levels will be given, possibilities below

Shaping:

• Depending on how the mouth is cut, it is easy or hard to open



Figure 74 Two alternatives





- Training of hand strength
 - "Knulli" at the affected hand
 - Use the easy/hard "Knulli"
 - Take it with the whole hand/take it only with the fingers
 - Open the mouth for long/less time
- Training of dexterity
 - "Knulli" at the unaffected hand
 - Using more small objects or using more big objects
 - Pick every piece separately
 - Collect lots of objects into the hand an put it separate into the mouth
 - Less/plenty objects



Figure 75 Squeezed "Knulli"

Figure 76 Possible objects

1.6.2.5 Cans

Goal:

• Better outcome of arm moves, grasp, coordination, strength endurance

Structure:

- Used material: stair-designed frame, cans, weights
- Construction of a stair-designed frame, left and right or around the Screen







- The task is to put the can or cans on the given step or build up a construction
- Time is measured and given as a feedback
- Different settings of tasks/levels will be given, possibilities below [instructions from the screen (number of repetition, direction, height, time)]

Shaping:

- Different weights of cans
- Different numbers of cans (less/10 to many/plenty/25)
- Different heights (desk level up to highest level)
- According to "AAT"
 - 1min. 3 cans up \rightarrow 3 cans down, as often as possible
- Task examples (fig.77-79):

Build a tower, in front, on a step, on the top,...

Build a pyramid with reversed cans , in front, on the top, ...











Figure 77 Build a tower

Figure 78 Arrange by colour Figure 79 Arrange on top

1.6.2.6 Multifunction Board

Goal:

Better outcome of grasp, dexterity, arm moves, coordination, strength endurance •

Structure:

- Used material: Multifunction board, sticks, bolts, ropes •
- The board offers a large variety of therapeutic exercises by using sticks, bolts and ropes •







- Board of plexiglass with 64 "holes"
- Every hole with an incorporated thread
- In every thread is an added keyway

Two possibilities:

• Use real nuts or mill a thread directly into the plexiglass board



Two sticks and a bolt



- Horizontal use and its tasks:
 - The patient has several sticks in his hand and put it separately into the holes
 - To screw bolts into nuts/threats
 - Playing "Solitaire the anchoretic game" to put away



Figure 80 Board example





- Vertical use and its tasks:
 - To run in with a rope also by using instruction on screen, on board
 - To knot
- Time is measured and given as a feedback
- Different settings of tasks/levels will be given, possibilities above [instructions from the screen]

Shaping:

- Horizontal / vertical use of the board
- Less / plenty sticks
- Kind of used stick
- Instruction

1.6.2.7 Cube

Goal:

• Better outcome of grasp, dexterity, coordination of fingers combined with selective finger moves

Structure:

- Used material: cubes of three sizes (small, medium, big), with originally points or colors (fig.81)
- The task is to rotate the cube in the given way (fig.82-84)
- Time is measured and given as a feedback
- Different settings of tasks/levels will be given
- <u>Cube as a controller</u>
 - Play a song/video by turning the cube in the palm of the paretic hand (open and read "Fun-mails"/Slogans; start a comic; start an audio story and play it with the right speed/tempo)



Figure 81 Cube examples



Shaping:

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Figure 82 Cube turning1



Figure 83 Cube turning2



Figure 84 Cube turning3

• Use of cubes of different sizes

- Duration of exercises
- Speed of rotation

1.5.3 Music Supported Therapy

This subset of training intervention is employable for patients with mild to moderate impairments. No musical knowledge is necessary. A MIDI piano (only 8 white keys are needed g-g') is used (fig.85). The training is structured in 11 consecutive learning levels (see detailed description below). It is proposed to train 5 times a week with training sessions of 30 to 45 minutes. Repetition, shaping, and auditory feedback (acoustic-sensorimotor coupling) are the employed principles of motor learning. (*Schneider, S. (2007))*[5]



Figure 85 Keyboard

The patient is sitting at a height adjustable desk (in an ergonomic upright position). A blanket in front of the keyboard on the table enables the patient to lay down the lower arms (fig.86+87). The exercising note sequence or task is given or played at first by the therapist. In our case lightening keys of the pianos will give the instructions. Second, the patient tries to play the sequence. If it is necessary, the patient gets help from the lightening keys of the piano. The training program is adaptable/adjustable to the patients' needs by changing the number of played notes (1, 2,..., 8), the speed and sequences or numbers of the used fingers.





Each task should be done 3 to 5 times correctly before the next task or level follows. If the task is not correctly done the patient has to try again.



Figure 86 Training position from above



Figure 87 Training position side





Table 1: Manual MST

Level	Feature	Task	Appointment	Direction of	Kind of	Account	Occupational aspects	Operations of fingers
				movement	sequence	of trials	(active or passive)	
							- exercising MCP, PIP, DIP	
		1	2 3 4 5 6	78			distal phalanx middle phalanx Pip proximal phalanx	54 ³ 21 12 ³ 4 54 ³ 21 12 ³ 4 55
							radius Hand (Doral View)	
1	single	1	1234	up	in line	8	isolated movements	1/2/3/4/5
(1 note)	notes	2	8765	down	in line	8	of selective fingers	1/2/3/4/5
		3	1736	up/down	mixed	8		1/2/3/4/5
		4	111,222	replay 3x	in line	8		1,1,1/2,2,2/3,3,3
2	note	1	1 2, 2 3, 3 4	up	in line	7	isolated movements	1/2/3/4/5 & 1,2/2,3/3,4/4,5
(2 notes)	steps	2	1 2, 5 6, 2 3	up	mixed	7	of selective fingers, combined	1/2/3/4/5 & 1,2/2,3/3,4/4,5
		3	8 7, 7 6, 6 5	down	in line	7	movements of two	1/2/3/4/5 & 2,1/3,2/4,3/5,4
		4	6 5, 2 1, 8 7	down	mixed	7		1/2/3/4/5 & 2,1/3,2/4,3/5,4
		5	1 2, 2 1, 2 3	up/down in line	mixed	14		1/2/3/4/5 & 1,2/2,1/2,3/3,2
		6	4 5, 7 6, 1 2	up/down mixed	mixed	14		1/2/3/4/5 & 1,2/2,1/2,3/3,2
3 (2 notes)	note range	1	1 2, 1 3, 1 4	up	in line	7	isolated movements of selective fingers,	1/2/3/4/5 & 1,1/1,2/1,3/1,4/1,5
		2	8 7, 8 6, 8 5	down	in line	7	→ jump combined	1/2/3/4/5 & 5 1/4 1/3 1/2 1/1 1
		3	1 2, 2 1, 1 3	up/down in line	in line	14	movements of two fingers	1/2/3/4/5 & 1,2/2,1/1,3/3,1
		4	1 4, 1 7, 1 3	up mixed	mixed	7		1/2/3/4/5 & 1 1/1 2/1 3/1 4/1 5
		5	8 7, 8 3, 8 4	down mixed	mixed	7		1/2/3/4/5 & 5 1/4 1/2 1/2 1/1 1
		6	1 4, 3 1, 1 3	up/down mixed	mixed	14		1/2/3/4/5 & 1,2/2,1/1,3/3,1
4 (2 mater)	note	1	1 2 3, 2 3 4	up	in line	6	isolated movements	1/2/3/4/5 & 1,2,3/2,3,4
(3 notes)	steps	2	456,234	up	mixed	6	combined	1/2/3/4/5 & 1,2,3/2,3,4
		3	876,765	down	in line	6	movements of three neighboured fingers	1/2/3/4/5 & 3,2,1/4,3,2
		4	4 3 2, 6 5 4	down	mixed	6	combined	1/2/3/4/5 & 3,2,1/4,3,2
		5	1 2 3, 3 2 1	up/down in line	mixed	12	movements with jump	1/2/3/4/5 & 1,2,3/3,2,1/2,3,4
		6	6 7 8, 5 4 3	up/down	mixed	12		1/2/3/4/5 & 1,2,3/3,2,1/2,3,4
				mixed				1,2,1/2,3,2 all directions
5 (3 notes)	Note range	1	124,125	up	in line	15	combined movements of three	1,2,3/1,2,4/1,2,5/2,3,5
(2.1.5000)	Tauge	2	134,145	up	in line	15	different fingers	1,2,3/1,3,4/1,4,5/2,4,5
		3	4 3 1, 5 4 1	down	in line	15		4,3,1/5,4,1/5,4,2





		3	4 3 1, 5 4 1	down	in line	15		4,3,1/5,4,1/5,4,2
		4	4 2 1, 5 2 1	down	in line	15		4,2,1/5,2,1/5,3,2
6 (4 notos)	note	1	1 2 3 4, 2 3 4 5	up	In line	5	isolated movements	1/2/3/4/5 & 1,2,3,4/2,3,4,5
(4 110(03)	steps	2	4567,1234	up	mixed	5	combined	1/2/3/4/5 & 1,2,3,4/2,3,4,5
		3	8765,7654	down	in line	5	movements of four	1/2/3/4/5 & 4,3,2,1/5,4,3,2
		4	4 3 2 1, 6 5 4 3	down	mixed	5	combined	1/2/3/4/5 & 4,3,2,1/5,4,3,2
		5	1 2 3 4, 4 3 2 1	up/down in line	mixed	10	movements with jump	1/2/3/4/5 & 1,2,3,4/4,3,2,1
		6	4567,4321	up/down	mixed	10		1/2/3/4/5 & 1,2,3,4/4,3,2,1
				mixed				1,2,1,2/2,3,2,3 all directions
7 (4 notes)	note range	1	1345,1456	up	in line	10	combined movements of four	1,2,3,4/2,3,4,5/1,3,4,5
(4 1101003)	Tunge	2	1245,1256	up	in line	10	different fingers	1,2,3,4/2,3,4,5/1,2,4,5
		3	1235,1236	up	in line	10		1,2,3,4/2,3,4,5/1,2,3,5
		4	5431,6541	down	in line	10		4,3,2,1/5,4,3,2/5,4,3,1
		5	5 4 2 1, 6 5 2 1	down	in line	10		4,3,2,1/5,4,3,2/5,4,2,1
		6	5321,6321	down	in line	10		4,3,2,1/5,4,3,2/5,3,2,1
8 (5 notes)	note steps	1	1 2 3 4 5, 2 3 4 5 6	up	in line	4	isolated movements of selective fingers,	1/2/3/4/5 & 1,2,3,4,5
		2	45678,1234 5	up	mixed	4	combined movements of five	1/2/3/4/5 & 1,2,3,4,5
		3	87654,7654 3	down	in line	4	neighboured fingers, combined movements with jump	1/2/3/4/5 & 5,4,3,2,1
		4	5 4 3 2 1,7 6 5 4 3	down	mixed	4		1/2/3/4/5 & 5,4,3,2,1
		5	1 2 3 4 5, 5 4 3 2 1	up/down in line	mixed	8		1/2/3/4/5 & 1,2,3,4,5/5,4,3,2,1
		6	54321,8765 4	up/down mixed	mixed	8		1/2/3/4/5 & 1 2 3 4 5/5 4 3 2 1
								1,2,1,2,3/2,3,2,3,4 all directions
9	Note	1	13456,124	up	in line	12	combined	1,2,3,4,5
(5 notes)	range	2	56		ter Bare	10	movements of five	4 2 2 4 5
		2	46	up	in line	12	unerent migers	1,2,3,4,5
		3	65431,654 21	down	in line	12		5,4,3,2,1
		4	65321,643 21	down	in line	12		5,4,3,2,1
10	note	1	scale	easy	in line	6	isolated	1,1,1/2,2,2/3,3,3 &
(song	range					_	movements of	1/2/3/4/5
beginnings /	note	2	note repetitions	easy	in line	/	selective fingers, combined movements up to five neighboured fingers	1,1,1/2,2,2/3,3,3 & 1/2/3/4/5
2-8 notes)	steps	3	scale	moderate	in line	8		1,1,1/2,2,2/3,3,3 & 1/2/3/4/5
		4	note repetitions	moderate	in line	8		1,1,1/2,2,2/3,3,3 & 1/2/3/4/5
		5	five-note sequence	advanced	in line	6		1,1,1/2,2,2/3,3,3 & 1/2/3/4/5



Telemedicine System empowering stroke patients to fight back

Project # FP7-ICT-StrokeBack-288692



		7	All songs	difficult	mixed	100		1,1,1/2,2,2/3,3,3 & 1/2/3/4/5
11 (10A) (songs/2-8 notes)	Note steps/ range	1	Scale/note repetitions/ note jumps	Easy/ moderate/ advanced/ difficult	In line/ mixed	20	Isolated movements of selective fingers, combined movements up to five neighboured fingers	1,1,1/2,2,2/3,3,3 & 1/2/3/4/5

Explanation of the schedule

Key 5 = d	Description of fingers	In line = systematic up and down of single notes
Кеу 6 = е	1 = thumb	Mixed = up and down of single notes alternate but
Key 7 = f	2 = index finger	Tandomised
Key 8 = g′	3 = middle finger	
	4 = ring finger	
	5 = little finger	
	Key 5 = d Key 6 = e Key 7 = f Key 8 = g [′]	Key 5 = dDescription of fingersKey 6 = e1 = thumbKey 7 = f2 = index fingerKey 8 = g'3 = middle finger4 = ring finger5 = little finger

Used folksongs and songs for children

Aufgabe 1	Aufgabe 2	Aufgabe 3
Alle meine Entchen* Fuchs du hast die Gans gestohlen* Herm Pastor sin Kauh Horch was kommt von draußen rein Ist ein Mann in Brunnen g`fallen Abend auf dem großen Platz	Au clair de la lune* Auf der Mauer, auf der Lauer* Das Lied von den Gespensterchen Sur le pont d'Avignon* Eine kleine Supermaus Wie schön, dass du geboren bist Ich kenne einen Cowboy	Eine kleine Geige möchte ich haben* Jim Knopf und Lukas der Lokomotivführer Bruder Jakob Die Frösche Merrily we roll along* Hejo, spann den Wagen an Was soll das bedeuten Winter ade
Aufgabe 4	Aufgabe 5	Aufgabe 6
Freude schöner Götterfunken* Sascha liebt nicht große Worte Old Mac Donald* Pimpernelle Zwiebelhaut Ringel, Ringel, Reihe Häschen in der Grube Ringlein, Ringlein du musst wandern* Wenn ich ein Vöglein wär'*	Der Kuckuck und der Esel* Hänsel und Gretel* Kuckuck, Kuckuck ruft`s aus dem Wald* Schlaf Kindlein schlaf* Hänschen klein* Die Vogelhochzeit*	Jolly good Fellow Zwischen Berg und tiefem Tal* Unsre Katz heißt Morle Oh wie wohl ist mir am Abend Der Mond ist aufgegangen* Kommt ein Vogel geflogen Happy Birthday*
Aufgabe 7	•	
Alle Lieder		

*level 11 (10a)-Songs





2 Conclusions

This deliverable presents the rehabilitation exercises pursued in StrokeBack in detail and describes the scientifical and practical principles underlying these exercises. These exercises were presented to and accepted by the other consortia partners during the meeting in Southampton in February 2012. We will rely on three different types of interventions, i.e. "Selective Repetitive Movements" combined with serious gaming, "Using objects" accorded to Arm Ability Training and "Music Supported Therapy".

In collaboration with IHP and UP we conducted first tests to check the technical possibilities and limitations of the proposed exercises when capturing movements with a single camera.





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